DECLARATION

I, YUZURU OKABE, a Japanese Patent Attorney registered No. 9411, of Okabe International Patent Office at No. 602, Fuji Bldg., 2-3, Marunouchi 3-chome, Chiyoda-ku, Tokyo, Japan, hereby declare that I have a thorough knowledge of Japanese and English languages, and that the attached pages contain a correct translation into English of the priority documents of Japanese Patent Application No. 5-121480 filed on May 24, 1993 in the name of CANON KABUSHIKI KAISHA.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made, are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 6th day of March, 2002

YUZURU OKABE

PATENT OFFICE
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This is to certify that the annexed is a true copy of the following application as filed with this Office.

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Applicant(s): CANON KABSHIKI KAISHA

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[Title of the Invention] Ink-jet Recoridng Apparatus, Ink-jet Recording Method, and Recorded Articles

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[Title of the Invention] Ink-jet Recording Apparatus, Ink-jet Recording Method, and Recorded Articles

[What is Claimed is]

[Claim 1]

An ink-jet recording apparatus for forming an image by discharging ink onto a recording medium by using a plurality of ink discharge means capable of discharging a plurality of inks with different densities, characterized in that:

at least two of said plural ink discharge means discharge inks which differ in density and penetrability on the recording medium.

[Claim 2]

The ink-jet recording apparatus according to claim 1, wherein said inks which differ in density and penetrability on the recording medium are inks of the same color group.

[Claim 3]

The ink-jet recording apparatus according to claim 1 or 2, wherein said ink discharge means is means which discharges an ink by utilizing heat energy and which is provided with a thermal energy converting member for generating heat energy to be given to an ink.

[Claim 4]

The ink-jet recording apparatus according to claim 3, wherein said ink discharge means causes an ink to develop a state change by the heat energy applied by said thermal energy converting member, thereby discharging the ink through a discharge port according to said state change.

[Claim 5]

An image forming apparatus characterized by comprising an ink-jet recording apparatus according to any one of claims 1 to 4 and an original image reading means.

[Claim 6]

An image forming apparatus characterized by comprising an ink-jet recording apparatus according to any one of claims 1 to 4 and an image information transmitting and/or receiving means.

[Claim 7]

The image forming apparatus according to claim 6, further comprising an original image reading means.

[Claim 8]

An image forming apparatus characterized by comprising an ink-jet recording apparatus according to any one of claims 1 to 4 and a recording signal input means.

[Claim 9]

The image forming apparatus according to claim 8, wherein said recording signal input means is a keyboard.

[Claim 10]

An ink-jet recording method for forming an image by applying a plurality of inks with different densities

onto a recording medium, comprising:

a step of applying inks which differ in density and penetrability on the recording medium so as to form an image.

[Claim 11]

A recorded article characterized in that:

an image is formed on a recording medium by using a plurality of inks which differ in density and penetrability on the recording medium.

[Detailed Description of the Invention]

[0001]

[Field of the Industrial Utilization]

The present invention relates to an ink-jet recording apparatus and an ink-jet recording method for performing recording by discharging dark and light inks onto a recording medium, as well as resulting recorded articles.

[0002]

[Prior Art]

In the conventional ink-jet recording method, ink is discharged from a plurality of ink discharge ports, which are formed in a recording head, in accordance with data signals and the ink droplets are caused to adhere to a material to be recorded on such as paper. This recording method is employed for a printer, facsimile, and copier, for example.

[0003]

In the aforesaid apparatus, there are methods available, including one using an electrothermal energy

converter, wherein a heating device (electrothermal energy transducer) is provided, for discharging ink, in the vicinity of a discharge port, and an electrical signal is applied to the heating device to heat the ink locally to cause pressure change, thereby discharging the ink through the discharge port, and another method wherein an electromechanical transducer such as a piezoelectric device.

[0004]

In this type of recording method, the recording control for medium tone according to a dot density control method, wherein the number of recording dots per unit area is controlled by a recording dot of a fixed size in order to represent the medium tone, or a dot diameter control method, wherein the size of the recording dot is controlled to represent the medium tone is carried out.

[0005]

The latter dot diameter control method has restrictions because it requires complicated control; therefore, the former dot density control method is commonly used.

[0006]

Further, the use of the electrothermal energy converter, which can be manufactured more easily and which permits higher density and accordingly higher resolution, as the ink discharging means, makes it difficult to control a pressure variation and also makes it impossible to change

the diameter of the recording dot. For this reason, the dot density control method is used.

[0007]

There is a systematic dither method as one of the typical binary techniques for representing medium tone used for the dot density control method, however, this method is disadvantageous in that the number of gradation levels is limited by a matrix size. To be specific, to increase the number of gradation levels, it is necessary to increase the matrix size, but increasing the matrix size causes a picture element of a recorded image comprised of a single matrix to grow larger with resultant lower resolution, thus posing problems. There is a conditioned decisive dither method such as an error diffusion method as another typical binary technique. This is a method, wherein a threshold value is changed, considering a peripheral picture element of an input picture element, while the aforesaid systematic dither method is an independent decisive dither method, wherein a threshold value, which is independent of an input picture element, is used for binarizing. The conditioned decisive dither method represented by this error diffusion method provides such advantages as good compatibility of gradation performance and resolution and minimized chances of a moire pattern occurring in a recorded image when an original image is a printed image, however, it also presented a problem in that grainy look in a lighter part of an image is more noticeable, leading to lower rating of

the image quality. This problem was especially marked in a recording apparatus with a lower recording density.

[0008]

To make the grainy look less conspicuous, a recording method has been proposed, wherein the conventional ink-jet recording apparatus is provided with two recording heads which discharge an ink of a low density and an ink of a high density; recording dots are formed with the ink of the low dye density for the light to medium tone parts of the image and the recording dots are formed with the ink of the high density for the medium to dark parts. The use of a dark/light multi-value recording method, wherein a plurality of dark and light inks with different densities are used for a single color, improves the gradation of a highlighted part simply by upgrading from binary to ternary and decreases the dot graininess, resulting in a higher image quality. This is achieved by imbedding the ink of a lower density (lighter) for the highlighted part, thereby eliminating the noise of a single dot.

[0009]

[Problems to be Solved by the Invention]

This dark/light multi-value recording method, however, permits the elimination of the graininess by increasing the number of dye density levels of the dark and light inks. On the other hand, increasing the number of the density levels unavoidably increases the number of

recording heads and ink tanks and also the size of a carriage carrying them, leading to an increased size of the whole apparatus. There are also limitation on the available number of different dark and light inks, two to four at the most. These restrictions are more marked especially in a color recording apparatus, and posed problems such as the impossibility of satisfactory reduction in the graininess in a highlighted part even when the method described above is used, and the reproduced gradation of an area, where the light ink is taken over by the dark ink, cannot be rendered linear when there is a significant difference in dot density between the dark and light color inks.

[0010]

The present invention has been achieved in view of the problems discussed above, and it is an object thereof to provide an ink-jet recording apparatus and an ink-jet recording method which enable satisfactorily controlled graininess even with a fewer types of dark and light inks and permits recording with excellent gradation, and recorded articles.

[0011]

[Means for Solving the Problems]

The present invention for fulfilling the object mentioned above is an ink-jet recording apparatus, which forms an image by discharging inks on a recording medium by using a plurality of ink discharging means which are capable of discharging a plurality of inks with different

densities, at least two of the ink discharging means discharging inks which differ in density and penetrability.

[0012]

Further, according to the present invention, an ink-jet recording method is provided, wherein a plurality of inks with different densities are deposited on a recording medium to form an image, the image being formed by depositing inks on the recording medium, the inks having different densities and penetrability on the recording medium.

[0013]

Still further, according to the present invention, a recorded article is provided, wherein an image has been formed on a recording medium by using a plurality of inks which differ in density and penetrability on a recording medium.

[0014]

[Mode of Operation]

According to the present invention, an image is formed by depositing inks, which differ in density and penetrability on a recording medium. This produces an image which is free of graininess and which exhibits good gradation.

[0015]

[Embodiments]

The embodiments which apply the present inventions will now be described specifically with reference to the

drawings.

[0016]

(1st Embodiment)

Fig. 1 is the perspective view which shows the configuration of the major section of the color ink-jet recording apparatus in the first embodiment of the present invention.

[0017]

A recording head 12A, which has the discharge port trains discharging a thick ink, and a recording head 12B, which has the discharge port trains discharging a thin ink, are installed on a carriage 23 with a specified distance between them.

[0018]

A material to be recorded on P consisting of paper, a plastic thin plate or the like is held by delivery rollers 21 via delivery roller (not shown), and it is fed in the direction of the arrow as a delivery motor, which is not shown, is driven.

[0019]

A guide shaft 22 and an encoder (not shown) guide and support the carriage 23.

[0020]

The carriage 23 is shuttled along the guide shaft 22 mentioned above by a carriage motor 25 via a drive belt 24.

[0021]

Provided inside (liquid passage) of the ink discharge ports of the recording heads are a heat generating device (electrothermal energy transducer) which generates heat energy for discharge the ink.

[0022]

An image can be formed by driving the heat generating device in accordance with a recording signal and the reading timing of the encoder (not shown), and by jetting and depositing the ink droplets onto the material to be recorded on P in the sequence of the thick ink color and the thin ink color.

[0023]

A restoring unit, which has a cap unit 26, is disposed in the home position (HP) of the carriage, the home position being selected outside the recording area. When recording is not performed, the carriage 23 is moved to the home position (HP) and the ink discharge port surface of the corresponding recording head is tightly sealed by a cap of the cap unit 26, thus preventing clogging caused by adhering ink due to an evaporated ink solvent or by adhering foreign matters such as dust.

[0024]

Further, to prevent defective discharge or clogging of the ink discharge ports, which are less frequently used, the capping function of the cap section is used for an idle discharge mode, wherein the ink is discharged to the cap unit 26 away from the ink discharge ports, or for restoring

the discharge of an ink discharge port, which has developed a discharge failure, by operating a pump, which is not illustrated, with the cap closed in order to suction the ink from the ink discharge port. Furthermore, the ink discharge port surface can be cleaned by disposing a blade or wiping component near the cap unit.

[0025]

Fig. 2 is the schematic perspective view of the ink discharge port trains of the recording head 12 observed from the side of the material to be recorded on; the recording head 12 is moved in the scanning direction denoted by y in the drawing. Fig. 3 is a partial perspective view which schematically shows the structure of the ink discharge unit. This shows the thick ink head 12A and the thin ink head 12B arranged in parallel, each recording head having a discharge port surface 1, which has a plurality of open discharge ports 2, and a discharge energy generating device 4 for generating the energy, which is required to discharge the ink to a liquid passage section 3 communicated with the discharge port 2, is disposed. The arrow y shows the scanning direction of the carriage 23. A reference numeral 5 of Fig. 3 is a sensor for detecting the temperature of the recording heads. In this embodiment, the diode sensors 5 are provided on both ends of the discharge port trains. There is no particular limitation to the temperature detecting means; other sensors such as thermistors may be used, and further, a method, whereby the head temperature is calculated from the

duty of a printed dot may be used.

[0026]

Fig. 4 is the block diagram which shows the configuration of the color ink-jet recording apparatus in the embodiment.

[0027]

In Fig. 4, 41 denotes an image input unit which optically reads an original image by CCD or the like, or receives an image luminance signal (RGB) from a host computer or video equipment, and 42 denotes a control unit provided with various keys for setting diverse parameters and instructing print start. A reference numeral 43 indicates a CPU which controls the whole recording apparatus in accordance with various programs in a ROM. A reference numeral 44 indicates a ROM which stores primarily the program for operating the recording apparatus in accordance with a control program and an error processing program. In this ROM, 44a indicates an input gamma conversion table, which is referred to for the processing in an input gamma conversion circuit, 44b indicates a masking coefficient, which is referred to for the processing in a color correction (masking) circuit, 44c indicates a black generating and UCR table, which is referred to for generating black and the processing in a UCR circuit, 44 indicates a dark/light distribution table, which is referred to for the processing in the dark/light distribution circuit to be discussed later, and 44e indicates a program group which stores the diverse

programs mentioned above. A reference numeral 45 denotes a RAM which is used as a work area of various programs in the ROM and as a temporary save area for processing an error. Further, 46 denotes a processing unit which performs the image signal processing to be discussed later, and 47 denotes the printer unit which forms a dot image in accordance with the image signal which has been processed by the image signal processing unit during recording. A reference numeral 48 shows a bus line which transmits address signals, data, control signals, etc. in the apparatus.

[0028]

The image signal processing unit will now be described.

[0029]

Fig. 5 shows the block diagram of the image signal processing system. The image processing circuit 51 mainly involves masking and UCR (Under Color Removal) processing, and it is compatible with all general image processing flows.

[0030]

Incidentally, the monocolor data after color processing are taken into a subsequent dark/light distribution processing circuit 52 wherein the received data are distributed into the thin ink data and the thick ink data according to the dark/light distribution table 44d.

[0031]

An example of the conversion graph of the dark/light distribution table is shown in Fig. 6. The solid line corresponds to the light ink data, while the broken line with a single dot corresponds to the dark ink data; if the value of 8-bit monocolor data is within a range of 0 to 128, then the dark ink data is output as "0" and the light ink data is output within a range of "0 to 255"; if the value of the monocolor data is within a range of 128 to 255, then the dark ink data are output, corresponding to "0 to 255" while the light ink data are output, corresponding to "255 to 0." In short, in this embodiment, when input data are lower values (in the case of a highlighted image), the ink with a lower dye density (thin ink) is mainly used, while, when input data are higher values, the ink with a higher dye density is used for recording.

[0032]

In the case of the ink-jet ink, it is possible to change the dot diffusion at the moment the ink droplets, which are discharged onto general paper such as a copy paper or bond paper, hit the paper, by changing the solvent composition of the ink.

[0033]

In general, the density of a dot with less diffusion is high and the dot is suited for producing a sharp image, however, it is apt to be slow in the penetration into the paper. In contrast to this type of dot, the dot with more diffusion has a lower dot density because the color matter

thereof diffuses, making the dot suitable for producing a halftone image because it forms a blurred image as a whole.

[0034]

The following shows an example of the ink composition used for this embodiment:

[0035]

Composition I (Example of the ink composition with low dot diffusion)

Dye	0.5 to 5 wt%
Glycerine	7.5 wt%
Thiodiglycol	7.5 wt%
Urea	7.5 wt%
Pure water	Remainder

[0036]

This type of ink exhibits good character quality on the general paper, including the copy paper and the bond paper. Generally, in the case of the ink-jet ink, it is said that the penetrability into paper grows faster as the value of $\eta / (\gamma \cos\theta)$ grows smaller, where η is the viscosity of the ink, γ is the surface tension of the ink, and θ is the angle of contact between the ink and the paper. In general, decreasing the contact angle leads to increased wettability of the ink with respect to the paper and therefore the penetrability into the paper quickens, while on the other hand, the ink tends to spread more easily on the paper surface and the resulting dots show poor sharpness, deteriorating the print quality. Decreasing the wettability with

respect to paper in the attempt to improve the print quality sacrifices the penetrability. The ink having the composition shown above has a surface tension of 40 to 50 dyne/cm, which belongs to an ink group of high surface tension, but the penetrability thereof into paper has been decreased with considerations given to the balance with fixing performance so as to prevent the ink from spreading on the paper surface and bleeding along uneven fibers (feathering phenomenon), thus achieving improved print quality.

[0037]

Composition II (Example of the ink composition with high dot diffusion)

Dye	0.5 to 5 wt%
Glycerine	7.5 wt%
Thiodiglycol	7.5 wt%
Acetylene glycol	
EO additive (N = 10)	5 wt%
Urea	7.5 wt%
Pure water	Remainder

EO: Ethylene oxide

[0038]

This type of ink exhibits extremely fast fixing performance even on the general paper such as copy paper and the bond paper, and it does not cause undue color blending (boundary smearing or bleed) even when ink recording areas of different colors adjoin each other in color recording,

thus presenting an advantage of uniform coloring (with minimized color irregularities).

[0039]

To diffuse dots, it is effective to set the contact angle θ at a small value and to make the ink highly wettable to paper; a surfactant is usually used to improve the wettability. In the case of the ink with composition II, the surface tension thereof is small, about 30 dyn/cm, because a nonionic surfactant is added, but the wettability with respect to paper is better; therefore, the ink diffuses more easily on a paper surface (larger dots) and the penetrability is extremely good. On the other hand, however, the larger dots mean less sharpness compared with the ink having composition I above and the density of dots is lower.

[0040]

Fig. 7 and Fig. 8 shows a conceptual difference between the dots on the paper, which are obtained when the ink of the ink composition I and the ink of ink composition II with the same dye density. Fig. 7 shows the dots produced with ink composition I; the dots do not diffuse but exhibit grainy look because the print density of dots themselves is high, leading to a high contrast with the paper. As shown in Fig. 8, however, in the case of ink composition II, the dots tend to diffuse and therefore the dye, which is the coloring material, also tends to spread as a whole, leading to a lower density of the dots themselves with a consequent lower contrast with a considerably reduced grainy look.

[0041]

Fig. 9 and Fig. 10 give conceptual illustrations of the character qualities obtained by using ink composition I and ink composition II. Fig. 9 shows the example wherein the ink of ink composition I is used, while Fig. 10 shows the example wherein the ink of ink composition II is used. The character quality obtained when the ink of composition I is very sharp and good, while the character produced when the ink of composition II is larger and unsharp as a whole.

[0042]

In this embodiment, ink composition I was used for the composition of the thick ink, while ink composition II was used for the composition of the thin ink. The use of the compositions enables the thick ink, which is frequently used for recording characters and fine lines, to perform sharp and good-quality recording; and the use of the dot-diffusing ink for the thin ink, which is used for halftone recording or especially for recording a highlighted part, allows the grainy look of the highlighted part to be less noticeable. Further, the graininess, which develops if there is a great difference in dot density between the thick ink and the thin ink in a thick-ink and thin-ink switching area, can be made less noticeable in this embodiment as shown in Fig. 11 wherein the thick-ink dots spread toward the thin-ink dot recorded area when the thin-ink dots and the thick-ink dots contact, leading to a smaller difference in density. This is interpreted that

the thin ink includes the surfactant and the thin-dot recorded area permits easy wetting due to the adhering surfactant, thus allowing the thick-ink dots contacting the thin-ink dots to diffuse easily.

[0043]

The way the thick-ink dots diffuse at that time may change depending on the order in which the thick ink and the thin ink are embedded. More specifically, immediately after the thick ink is embedded, the thin ink is embedded in this embodiment; the thick ink has slower penetrability and the thin ink is embedded before the thick ink is fully fixed; therefore, the inks are easily mixable on the paper surface. On the other hand, when the thin ink with faster penetrability is embedded first, and then the thick ink with slower penetrability is embedded, the inks are difficult to mix on the paper surface since the thin ink is quickly penetrates the paper, thus reducing the bleeding. This changes, depending also on the combination of the ink compositions; therefore, the embedding sequence of the thick and thin inks should be determined with considerations given to those factors.

[0044]

Nonionic surfactants, which are good as the penetrants used for the thin ink, include the anionic surfactants such as the aerosol OT, dodecyl benzene sodium sulfonate, and lauryl sodium sulfate, a higher alcohol ethylene oxide addition product, which is expressed by

general formula [1] shown below, an alkylphenol ethylene oxide addition product, which is expressed by general formula [2] shown below, an ethylene oxide - propylene oxide copolymer expressed by general formula [3] shown below, and an acetylene glycol ethylene oxide addition product expressed by general formula [4] given below.

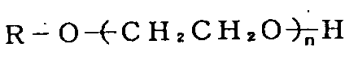
[0045]

The anionic surfactants listed above, however, are highly foamy and inconvenient in handling, and the nonionic surfactants are better than the anionic surfactants in image characteristics, including boundary bleeding, color uniformity, and feathering. For this reason, in this invention, the nonionic surfactants expressed by the general formulas given below were used:

[0046]

[Composed Font 1]

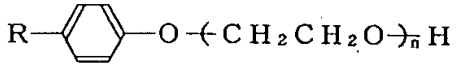
General Formula [1]



R: Alkyl group

n: Integer

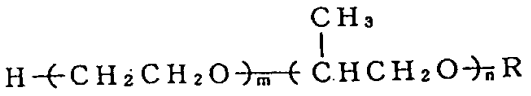
General Formula [2]



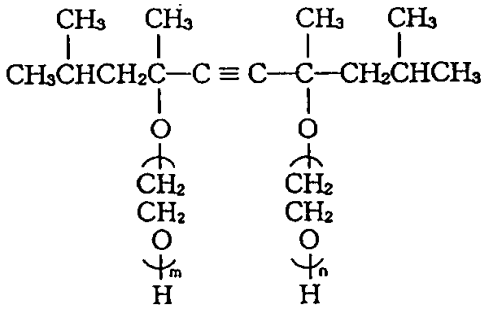
R: Alkyl group

n: Integer

General Formula [3]



General Formula [4]



R: Alkyl group or Hydrogen

m,n: Integers

m,n: Integers

[0047]

Among the ethylene oxide type nonionic surfactants listed above, the acetylene glycol ethylene oxide addition product is preferable because it is well balanced in the absorbency into an ink absorber, the image characteristics exhibited on a recording medium, the characteristic of discharge from the recording heads, and other properties. Furthermore, this compound is controlled in hydrophilic property and penetrability by a number, N, of the ethylene oxides to be added. If N is smaller than 6, then the penetrability is better, but water-solubility is poor, leading to poor solubility to inks. In the other hand, an excessive number of added ethylene oxides causes excessive hydrophilic property, resulting in lower penetrability. If N exceeds 14, then the penetrability deteriorates; just adding more is not effective, but it will rather adversely affect the discharge property. Thus, the number of ethylene oxides to be added for this compound should range from 6 to 14.

[0048]

The adding volume of these nonionic surfactants are preferably 0.1 to 20 wt%. This is because an adding volume of 0.1 % or less results in unsatisfactory image

characteristics and penetrability, while an adding volume of 20 % or more no longer provides any further effect and it will rather adversely affect cost and ink reliability.

[0049]

These nonionic surfactants may be used in a single form or in a combined form.

[0050]

In addition, as the ink components, a dye as the recording agent, a low-volatility organic solvent such as a polyatomic alcohol for preventing clogging, and an organic solvent such as an alcohol for the purpose of foam stability and fixing property on a recording medium are generally added as necessary.

[0051]

As a water-soluble organic solvent for forming the ink according to the present invention, there are, for example, the polyalkylene glycols such as polyethylene glycol and polypropylene glycol; the alkylene glycols, wherein an alkylene group includes 2 to 6 carbon atoms, Fuch as ethylene glycol, propylene glycol, butylene glycol, triethylene glycol, 1,2,6-hexanetriol, hexylene glycol, and diethylene glycol; glycerins; the polyatomic alcohol lower alkyl ethers such as ethylene glycol methyl ether, diethylene glycol methyl (or ethyl) ether, and triethylene glycol monomethyl (or ethyl) ether; the alcohols such as methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl alcohol, n-butyl alcohol, sec-butyl alcohol, tert-butyl

alcohol, isobutyl alcohol, benzyl alcohol, and cyclohexanol; the amides such as dimethylformamide and dimethylacetamide; the ketones or ketone alcohols such as aceton and diacetone alcohol; the ethers such as tetrahydrofuran, dioxane; and the nitrogen cyclic compound such as N-methyl-2-pyrrolidone, 2-pyrrolidone, and 1,3-dimethyl-2-imidazolidinon. These water-soluble organic solvents may be contained in a volume which does not deteriorate the image characteristics and discharge reliability. Preferable ones are the polyatomic alcohols or the polyatomic alcohol alkyl ethers, the desirable content being 1 to 30 wt%.

[0052]

At this time, the volume of the pure water in the ink used in the present invention is preferably 50 to 90 wt%.

[0053]

Dyes used in the present invention include direct dye, acid dye, basic dye, reactive dye, disperse dye, and vat dye. The content of these dyes is generally within a range of 0.5 to 15 wt% for the total weight of the ink, preferably within a range of 1 to 7 wt% although it is determined, according mainly to the type of the liquid medium components, the characteristics required of the ink, and the discharge of the recording head.

Further, it has been found that adding thiodiglycol or urea (or an inductor thereof) to the ink dramatically

improves the discharge characteristic and the effect for preventing clogging (binding). It is considered that adding them improves the solubility of the dyes into the ink. The preferable content of thiodiglycol or urea (or an inductor thereof) ranges from 1 to 30 wt%, and they may be added as necessary.

[0054]

The major components of the inks according to the present invention are as described above. A viscosity modifier such as polyvinyl alcohol, cellulose, and water-soluble resin; a pH modifier such as diethanolamine, triethanolamine, and buffer solution; mildewproofing agent, and the like may be further added as necessary in an extent that does not interfere with the objects of the present invention.

[0055]

To prepare the inks used for the ink-jet recording apparatus which is designed to charge the inks, a specific resistance modifier of an inorganic salt such as lithium chloride, ammonium chloride, and sodium chloride is added.

[0056]

In this embodiment, the monocolor ink was used as the example for the convenience of explanation, however, the embodiment is not limited to the same; the present invention may also be applied to a color recording apparatus which is provided with a thick ink and thin ink for each of a plurality of different colors such as cyan, magenta,

yellow, and black. Further, the dye density of the ink is not limited to two types, thick and thin, but it may be three or more types. For example, a low-density ink, a medium-density ink, and a high-density ink may be used for recording, so that the low-density ink and the medium-density ink may be used as the ink of composition II which allows dots to easily diffuse, while the high-density ink may be used as the ink of composition I which emphasizes the character quality.

[0057]

(Second Embodiment)

Fig. 12 is a perspective view which shows the configuration of the major section of the ink-jet recording apparatus in the second embodiment of the present invention, the operation thereof being basically the same as that of the first embodiment.

[0058]

Fig. 13 is the schematic perspective view of the ink discharge port trains of the recording head 12 observed from the side of the material to be recorded on.

[0059]

This is a single recording head 12 which has a discharge port train 2A, which discharges the thick ink, and a discharge port train 2B, which discharges the thin ink.

[0060]

When recording with the thick and thin inks, the

problem of the disagreement in landing point between the thick-ink dots and the thin-ink dots requires careful considerations because the positional discrepancy between the thick and thin dots may change the density. The discrepancy of the vertical and horizontal registrations is eliminated by dividing and disposing a plurality of discharge port trains, which discharge the inks of different densities, in the single recording head, thus eliminating the possibility of the discrepancy in the density gradation from the dot landing position.

[0061]

Fig. 14 is the explanatory drawing of the configuration of the ink-jet recording head used in the embodiment.

[0062]

One end of a wiring board 200 is interconnected with a wiring section of a heater board 100, and the other end of the wiring board 200 is provided with a plurality of pads, which correspond to the electrothermal energy converters for receiving electrical signals from the apparatus. This allows the electrical signals from the apparatus to be supplied to the respective electrothermal energy converters.

[0063]

A metallic support 300, which supports the rear surface of the wiring board 200 by the flat surface thereof, provides the bottom plate of an ink-jet unit. A holding

spring 500 has a section, which is bent so that the cross-section thereof is approximately U-shaped to linearly and elastically apply a pushing force to the area near the ink discharge port of a groove top 1300, hooks, which hook themselves by utilizing the relief holes provided in a base plate, and a pair of rear legs which receive the force acting on the spring on the base plate.

[0064]

The spring force presses the wiring board 200 in contact with the groove top 1300.

[0065]

The wiring board 200 is mounted on the support by adhesion using an adhesive agent or the like.

[0066]

The ends of ink supply pipes 2200 are provided with filters 700.

[0067]

An ink supply member 600 is produced by molding, the groove top having an orifice plate section 1301 and channel 1500 leading to the ink supply ports, which are made into one piece. The ink supply member 600 can be easily fixed to the support 300 by passing two pins (not shown) on the rear surface of the ink supply member 600 into holes 1901, 1902 of the support 300 and jutting them, then thermally fusing them.

[0068]

At this time, the clearance between the orifice

plate section 1301 and the ink supply member 600 is evenly formed. A sealant is poured through a top sealant pouring port of the ink supply member 600 to seal the wire bonding and also seal the clearance between the orifice plate section 1301 and the ink supply member 600, further pass through a groove 310, which is provided in a support base 300, then completely seal the clearance between the orifice plate section 1301 and the front end of the support base 300.

[0069]

Fig. 15 is the perspective view of the groove top 1300 of the recording head used in this embodiment, the groove top being observed from the heater board 100 side. A plurality of liquid chambers are provided, each liquid chamber being partitioned by a wall 10. Each liquid chamber has supply ports 20a and 20b through which the inks are supplied.

[0070]

There is provided a groove 30 at the pressure-contacted surface between the groove top and the heater board 100 of the wall 10 partitioning the liquid chambers. The groove is communicated with the outer peripheral section of the groove top 1300. After the groove top 1300 is pressure-contacted to bring it into close contact with the heater board, the outer peripheral section is sealed with the sealant as previously described. At this time, the sealant moves along the aforesaid groove to fill the

clearance between the groove top and the heater board. Thus, the technical process used for the conventional head can be used to completely separate the liquid chambers. The structure of the groove differs according to the physical property of the sealant, and it needs to be designed to match each physical property.

[0071]

Thus, separating a single liquid chamber into a plurality of chambers makes it possible to supply different inks through the respective ink discharge ports.

[0072]

Fig. 16 shows the recording head and the ink tank of the embodiment, which have been mounted on the carriage. The ink tank IT is partitioned into two chambers, top and bottom, the top chamber being filled with the thin ink, while the bottom chamber being filled with the thick ink. On the carriage 23, the recording head 12 and the ink tank IT are connected by pressure contact, supplying the thick and thin inks from the ink tank IT to the recording head 12.

[0073]

The method used, whereby input data are divided into the thin-ink data and the thick-ink data according to the dark/light distribution table, is the same as that in the case of the first embodiment; data C, M, Y, K entered in accordance with the dark/light distribution table are divided into the thin-ink data (C', M', Y', K') and the thick-ink data (C", M", Y", K"), binarized through the

binarizing circuit, and output to the recording head in the form of the ON/OFF data (1-bit signals).

[0074]

An example of the ink compositions used for the second embodiment is shown below:

Composition III (Example of the ink composition with low dot diffusion)

Dye	0.5 to 5 wt%
Diethylene glycol	5 wt%
Thiodiglycol	5 wt%
Ethyl alcohol	3 wt%
Pure water	Remainder

Composition IV (Example of the ink composition with high dot diffusion)

Dye	0.5 to 5 wt%
Glycerin	5 wt%
Thiodiglycol	5 wt%
Ethylene oxide-propylene oxide copolymer	3 wt%
Urea	5 wt%
Pure water	Remainder

[0075]

In this embodiment, the ink having composition III for less dot diffusion was used as the thick-ink composition ink and the ink having composition IV for more dot diffusion

as the thin-ink composition ink, the thick-ink nozzle train being disposed at the bottom and the thin-ink nozzle train at the top. In other words, in the medium-density area where both thin dots and thick dots are embedded, the thin-ink dots, which diffuse more, are embedded after the thick-ink dots, which diffuse less, are embedded. As it was mentioned in the first embodiment, the ink having the composition which allows less diffusion of dots exhibits poor penetrability with resultant slower fixing. In addition, in the vicinity of an area, where the thick and thin inks are switched and the graininess shows more easily, more dots of the thin ink are embedded than the dots of the thick ink. Hence, the thin-ink dots are embedded around the thick-ink dots, which have not yet been fully fixed, making the thick-ink dots and the thin-ink dots easier to blend, thus allowing the thick-ink dots to spread and controlling the grainy look.

[0076]

According to this embodiment, the discharge port train for discharging the thick ink and the discharge port train for discharging the thin ink are combined on the single recording head, thereby eliminating the need of more recording heads and enabling a reduced size of the apparatus.

[0077]

Moreover, in this embodiment, the thin ink and the thick ink are not overlapped by the same single carriage

scanning; instead, the thick ink is embedded by the first main scanning, then the paper is fed before the thin ink is added by the next main carriage scanning. According to the embodiment, it is possible to allow a time interval between the embedding of the thick ink and that of the thin ink; therefore, it is also possible to allow a penetrating time when the thick ink with slower penetration is embedded first, thus permitting the adjustment of the way the inks are diffused, in comparison with the first embodiment. Furthermore, when a bidirectional recording method is used, it is also possible to carry out control so that the diffusion stays the same for both forward and backward travels of the carriage main scanning.

[0078]

In this embodiment, the monocolor ink was used as the example for the convenience of explanation, however, the embodiment is not limited to the same; the present invention may also be applied to a color recording apparatus which is provided with a thick ink and thin ink for each of a plurality of different colors such as cyan, magenta, yellow, and black.

[0079]

Likewise, the dye density of the ink is not limited to two types, thick and thin, but it may be three or more types. For example, a low-density ink, a medium-density ink, and a high-density ink may be used for recording, so that the low-density ink and the medium-density ink may be used

as the ink of composition which allows dots to easily diffuse, while the high-density ink may be used as the ink of composition which emphasizes the character quality.

[0080]

(Third Embodiment)

Fig. 17 is the perspective view which shows the configuration of the major section of a color ink-jet recording apparatus in place of the recording apparatus in the second embodiment of the present invention, the operation thereof being basically the same as that of the second embodiment.

[0081]

Fig. 18 is the schematic perspective view of the ink discharge port trains of the recording head observed from the side of the material to be recorded on.

[0082]

This shows a color ink-jet recording apparatus which has the recording heads of four colors; a recording head 12C, which discharges the C (cyan) ink, a recording head 12M, which discharges the M (magenta) ink, a recording head 12Y, which discharges the Y (yellow) ink, and a recording head 12K, which discharges the K (black) ink. Each of the recording heads has a discharge port train 2A for discharging the thick ink and a discharge port train 2B for discharging the thin ink, the trains being installed on the carriage with a specified distance between them.

[0083]

When recording with the thick and thin inks, the problem of the discrepancy in landing point between the thick-ink dots and the thin-ink dots requires careful considerations because the positional discrepancy between the thick and thin dots may change the density. In this embodiment also, the discrepancy of the vertical and horizontal registrations is eliminated by dividing and disposing a plurality of discharge port trains, which discharge the inks of different densities, in the single recording head, thus eliminating the possibility of the discrepancy in the density gradation from the dot landing position.

[0084]

Fig. 19 shows the structure of a 4-head ink-jet cartridge (IJC), which has the recording heads of four colors, C, M, Y, and K assembled into one piece by a frame 3000. The four recording heads are mounted on the frame 3000 with specified intervals between them and fixed with the nozzle train direction thereof registered. A reference numeral 3100 is a frame cover, and 3200 is a connector for connecting the pads provided on the wiring board 200 of the four recording heads to the electrical signals received from the apparatus main body.

[0085]

Fig. 20 shows the 4-head ink-jet cartridge which has been mounted on the carriage. The ink tank (IT) is partitioned into two chambers, top and bottom, the top

chamber being filled with the thin ink, while the bottom chamber being filled with the thick ink. On the carriage 23, the ink-jet cartridge 3000 and the four ink tanks (IT) of C, M, Y, and K are connected by pressure contact, supplying the inks from the ink tanks to the recording heads.

[0086]

The method used, whereby input data are divided into the thin-ink data and the thick-ink data according to the dark/light distribution table, is the same as that in the case of the first embodiment; data C, M, Y, K entered in accordance with the dark/light distribution table are divided into the thin-ink data (C', M', Y', K') and the thick-ink data (C", M", Y", K"), binarized through the binarizing circuit, and output to the recording heads in the form of the ON/OFF data (1-bit signals).

[0087]

In the case of color recording, the diffusion in a boundary area of different colors when different colors adjoin is also important. The ink having the composition (composition I or III), which allows dots to diffuse easily as described in the first embodiment or the second embodiment, exhibits good penetration into paper and also presents an excellent characteristic in that no undue diffusion occurs in the boundary area of different colors. On the other hand, the ink having the composition (composition II or IV), which prevents easy diffusion of dots, exhibits poor penetration into paper and therefore

causes diffusion and blending in the boundary area of different colors on the paper surface, leading to a deteriorated image.

[0088]

In this embodiment, therefore, only the black thick ink adopted the ink composition, which prevents easy diffusion of dots, in order to enhance the quality of characters, fine lines, and the like, while the ink composition, which permits easy diffusion of dots and prevents diffusion in a different color boundary area, was adopted for the black thin ink and the thick and thin inks for cyan, magenta, and yellow in order to enhance the quality in color recording of a medium tone such as a picture of nature.

[0089]

The present invention brings outstanding effects especially in the ink-jet type recording heads and recording apparatuses which are designed to form flying droplets by utilizing heat energy to perform recording, among the ink-jet recording type recording heads or recording apparatuses.

[0090]

The preferable typical configurations and principles are the ones which employ the basic principle disclosed, for example, in the specification of US Patent No. 4723129 and the specification of US Patent No. 4740796. The method can be applied to both "on-demand type" and

"continuous type"; the on-demand type, in particular, is effective because by applying at least one drive signal, which corresponds to recording information and causes a quick temperature rise exceeding nuclear boiling point, to an electrothermal converter, which is disposed corresponding to a seat or liquid passage holding a liquid (ink), to generate heat energy in the electrothermal converter, thereby to cause the film boiling on the heat working surface of the recording head, consequently forming a foam in the liquid (ink), which exactly corresponds to the drive signal. The liquid (ink) is discharged through a discharge aperture by the growth, expansion and contraction of the foam, thereby forming at least one droplet. More preferably, the drive signal is formed into a pulse so that the foam will immediately and properly grow, expand and contract, achieving the discharge of the liquid (ink) featuring especially excellent responsiveness.

[0091]

As the pulse-shaped drive signal, the ones disclosed in the specification of US Patent No. 4463359 and the specification of US Patent No. 4345262 are suited. Further, even better recording can be accomplished by adopting the conditions described in the specification of the invention under US Patent No. 4313124, which are related to the temperature rising rate of the aforesaid heat working surface.

[0092]

As the configuration of the recording head, a configuration, wherein the heat working section is disposed in a bent area, may be alternatively used, the configuration being disclosed in the specification of US Patent No. 4558333 and the specification of US Patent No. 4459600 in place of the configuration combining the discharge ports, liquid passages, and electrothermal converters (linear liquid passages or right-angle liquid passages) as disclosed in the specifications mentioned above.

[0093]

As still another alternative configuration, the configuration based on the publication of unexamined JP patent application No. 59-123670 which discloses a configuration, wherein a common slit provides the discharge section of the electrothermal converter, or the configuration based on the publication of unexamined JP patent application No. 59-138461, wherein the aperture absorbing the pressure wave of heat energy is made relevant to the discharge section may be used.

[0094]

Further, as the full-line type recording head, which has a length corresponding to the width of the maximum recording medium on which the recording apparatus can record, either the configuration, wherein the length is satisfied by combining a plurality of recording heads as disclosed in the specifications mentioned above, or the configuration characterized by a single recording head formed as one piece

may be used.

[0095]

Still further, a replaceable chip type recording head, which permits electrical connection with the apparatus main body and the supply of the inks from the apparatus main body when it is mounted on the apparatus main body, or a cartridge type recording head, wherein ink tanks are provided integrally with the recording head itself, may be used.

[0096]

Adding a restoring means for the recording head, standby auxiliary means, etc. to the recording apparatus of the present invention is preferable because it adds to stable effects of the present invention. To be more specific, such preferable addition, which is effective for ensuring stable recording, includes a capping means for the recording head, a cleaning means, a pressurizing or suction means, a standby heating means consisting of an electrothermal converter or a separate heating element or a combination of the former two, and the implementation of the standby discharge mode wherein discharge independent of recording is performed.

[0097]

In the embodiments of the present invention described above, the description was given using the inks as the liquids; the inks solidify at or below room temperature, and most inks soften or remain liquids at room

temperature; or in the ink-jet method described above, the ink temperature is controlled so that the inks stay within a range of 30°C to 70°C to keep the viscosity of the inks within the stable discharge range; therefore, any inks are acceptable as long as they are liquids when the recording signal is applied.

[0098]

In addition, the rising temperature caused by the heat energy may be actively used as the energy for changing the state of the ink, that is, from the solid state to the liquid state; or an ink, which solidifies when it is let stand, may be used for the purpose of preventing the ink from evaporating; or an ink, which liquefies when heat energy is applied in response to the recording signal and which is discharged as a liquid ink; or an ink, which begins to solidify already at the point of reaching the recording medium; all those inks which liquefy only when heat energy is applied to the same, may be applied to the present invention. In such a case, the ink may be held as a liquid or solid material in a porous seat concave or a through hole, facing the electrothermal converter, as described in the publication of the unexamined JP No. 54-56847 or the publication of the unexamined JP No. 60-71260. In the present invention, implementing the film boiling method mentioned above is most effective for the inks described above.

[0099]

Still further, the recording apparatus according to the present invention may take a form of a copying apparatus combined with a reader or the like, or a facsimile apparatus having a transmitting and receiving feature, in addition to the form wherein the recording apparatus is provided in the form of an image output terminal as a part of or independently of information processing equipment such as a word processor and computer as mentioned above.

[0100]

Fig. 21 is the block diagram which shows the schematic configuration used when the recording apparatus of the present invention is applied to an information processing apparatus which has a function as a word processor, personal computer, facsimile apparatus, copying apparatus, electronic typewriter, etc. In the diagram, 201 is a controller which controls the whole apparatus; it is provided with a CPU such as a microprocessor and diverse I/O ports, and it performs control by issuing control signals, data signals and the like to all component units and by receiving control signals and data signals from all the component units. A reference numeral 202 denotes a display unit, the display screen thereof showing various menus, document information, and image data or the like read through an image reader 207. A reference numeral 203 denotes a transparent pressure-sensitive touch panel provided on the display unit 202; articles, coordinate positions, etc. can be entered on the display unit 202 by

pressing the surface of the touch panel by fingers or the like.

[0101]

A reference numeral 204 denotes an FM (frequency modulation) sound source unit which stores music information created by a music editor or the like in a memory 210 and an external memory 212 as digital data then reads out the stored data from the memory or the like to submit it to FM. The electrical signals from the FM sound source unit 204 are converted to audible sounds through a speaker 205. A printer 206 uses the recording apparatus according to the present invention as the output terminal of the word processor, personal computer, facsimile apparatus, copying apparatus, electronic typewriter, etc.

[0102]

A reference numeral 207 is an image reader which reads and inputs an original photoelectrically; it is provided in the middle of the original delivery passage and it reads various types of originals, including a facsimile original and copy original. A reference numeral 208 denotes a facsimile transmitting and receiving unit which transmits the original data read through the image reader 207 and receives and decodes transmitted facsimile signals, and it has a feature for interfacing with external equipment. A reference numeral 209 denotes a telephone unit which has various telephone functions, including regular telephone functions and an answering machine function. A reference

numeral 210 denotes is a memory which mainly contains a system program, manager program, and other application programs, a ROM for storing character fonts, dictionaries, etc., the application programs and character information loaded from the external memory 212, and a RAM.

[0103]

A reference numeral 211 is a keyboard through which document information, various commands, etc. are entered. A reference numeral 212 is the external memory which uses floppy disks, hard disks, and the like as its storage media; character information, music, sound information, user's application programs, etc. are stored in this external memory 212.

[0104]

Fig. 22 is the external view of the information processing apparatus shown in Fig. 21. In the drawing, 301 is a flat panel display which uses an LCD or the like, and it displays various menus, graphic information, character information, etc. The touch panel is provided on the display 301; coordinate inputs can be made or articles can be specified and entered by pressing the surface of the touch panel by fingers or the like. A reference numeral 302 indicates a handset which is used when the apparatus serves as a telephone.

[0105]

The keyboard 303 is connected removably with the main body through a cord, and it enables diverse types of

character information and diverse data to be entered. The keyboard 303 is further provided with function keys 304 or the like. A reference numeral 305 denotes a slit for inserting a floppy disk.

[0106]

A reference numeral 307 is a paper rest whereon an original to be read by the image reader 207 is placed; the original, which has been read, is ejected from the rear of the apparatus. In facsimile receiving, the printer 307 is used for recording.

[0107]

A CRT may be used for the aforesaid display 301, however, a flat panel such as a LCD display utilizing a ferroelectric liquid crystal is preferable. This is because a reduced weight can be achieved in addition to a reduced size and thickness. When using the information processing unit described above as a personal computer or a word processor, various information entered through the keyboard 211 is processed by the controller 201 in accordance with predetermined programs and the result is printed as an image on the printer 206 in Fig. 21. When the apparatus serves as a receiving unit of a facsimile apparatus, the facsimile information entered through the facsimile transmitting and receiving unit 208 via a communication line is processed for receiving by the controller 201 in accordance with a specified program and the result is printed as a received image on the printer

206.

[0108]

When the apparatus functions as a copying apparatus, an original is read through the image reader 207, and the read original data are printed as a copied image on the printer 206 via the controller 201. When the apparatus serves as a transmitter of the facsimile apparatus, the original data read through the image reader 207 are processed for transmission by the controller 201 in accordance with a specified program, then they are sent onto the communication line via the facsimile transmitting and receiving unit 208. The information processing apparatus described above may be designed to incorporate the printer in the main body as shown in Fig. 23 to enhance the portability. In the drawing, the parts, which have the same functions as those shown in Fig. 22, are given the corresponding reference numerals.

[0109]

Applying the recording apparatus of the present invention to the multi-functional information processing apparatus discussed above enables high-quality recorded images to be achieved, making it possible to further add to the features of the information processing apparatus.

[0110]

[Effect of the Invention]

As discussed above, according to the present invention, in an ink-jet recording apparatus, which is

designed to discharge a plurality of inks having different dye densities to form an image, providing at least two types of inks of different dye densities with different penetrability on a recording medium ensures smooth reproduction of medium tone (halftone) gradation with good print quality of black characters and fine lines and also enables recording of a natural image with least likelihood of the occurrence of pseudo contours and changes in the graininess and tone of the recorded image in an ink switching area.

[Brief Description of the Drawings]

[Figure 1]

A schematic explanatory drawing of an ink-jet recording apparatus according to the present invention.

[Figure 2]

A schematic partial perspective view of the area near the discharge port of a recording head.

[Figure 3]

A partial perspective view which schematically shows the structure of the ink discharge section of the recording head.

[Figure 4]

A block diagram which shows the configuration of the ink-jet recording apparatus.

[Figure 5]

A block diagram of an image signal processing unit.

[Figure 6]

An example of a conversion graph of a dark/light distribution table.

[Figure 7]

A diagram showing the state of the dots formed using an ink, the composition thereof making it difficult for dots to diffuse.

[Figure 8]

A diagram showing the state of dots formed using an ink, the composition thereof making it easy for dots to diffuse.

[Figure 9]

A diagram which shows a character quality produced using an ink, the composition thereof making it difficult for dots to diffuse.

[Figure 10]

A diagram which shows a character quality produced using an ink, the composition thereof making it easy for dots to diffuse.

[Figure 11]

A diagram which shows the state of dots wherein the dots, which have been produced using an ink, the composition thereof making it easy for the dots to diffuse, are in contact with the dots, which have been produced using an ink, the composition thereof making it difficult for the dots to diffuse.

[Figure 12]

A schematic explanatory diagram of an ink-jet

recording apparatus, to which the second embodiment of the present invention applies.

[Figure 13]

A schematic partial perspective view of the area near the discharge port of the recording head of the second embodiment.

[Figure 14]

An explanatory diagram of the configuration of the recording head.

[Figure 15]

A perspective view which illustrates the structure of a groove top.

[Figure 16]

An explanatory diagram which shows the recording head and the ink tanks mounted on the carriage.

[Figure 17]

A schematic explanatory diagram of an ink-jet recording apparatus, to which the third embodiment of the present invention applies.

[Figure 18]

A schematic partial perspective view of the area near the discharge port of the recording head of the third embodiment.

[Figure 19]

An explanatory diagram of the configuration of the ink-jet cartridge with four heads formed into one piece.

[Figure 20]

An explanatory diagram which shows the ink-jet cartridge and the ink tanks mounted on the carriage.

[Figure 21]

A block diagram which shows the schematic configuration wherein the recording apparatus according to the present invention applies to an information processing apparatus.

[Figure 22]

An external view of the information processing apparatus.

[Figure 23]

An external view showing another example of the information processing apparatus.

[Description of Reference Numerals or Symbols]

12, 12A, 12B, 12K, 12C, 12M, 12Y ... recording heads

21 ... delivery rollers

22 ... guide shaft

23 ... carriage

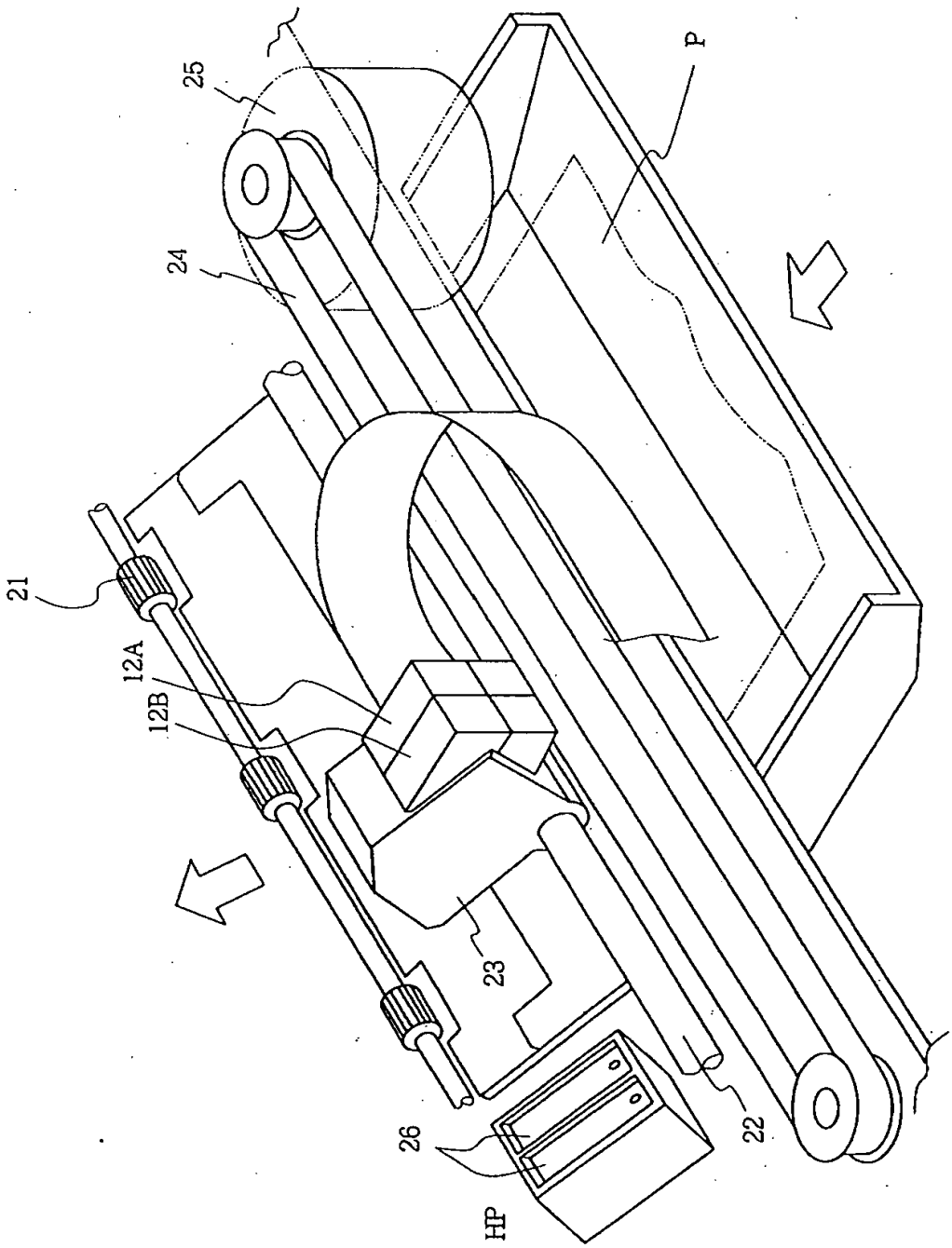
24 ... drive belt

25 ... carriage motor

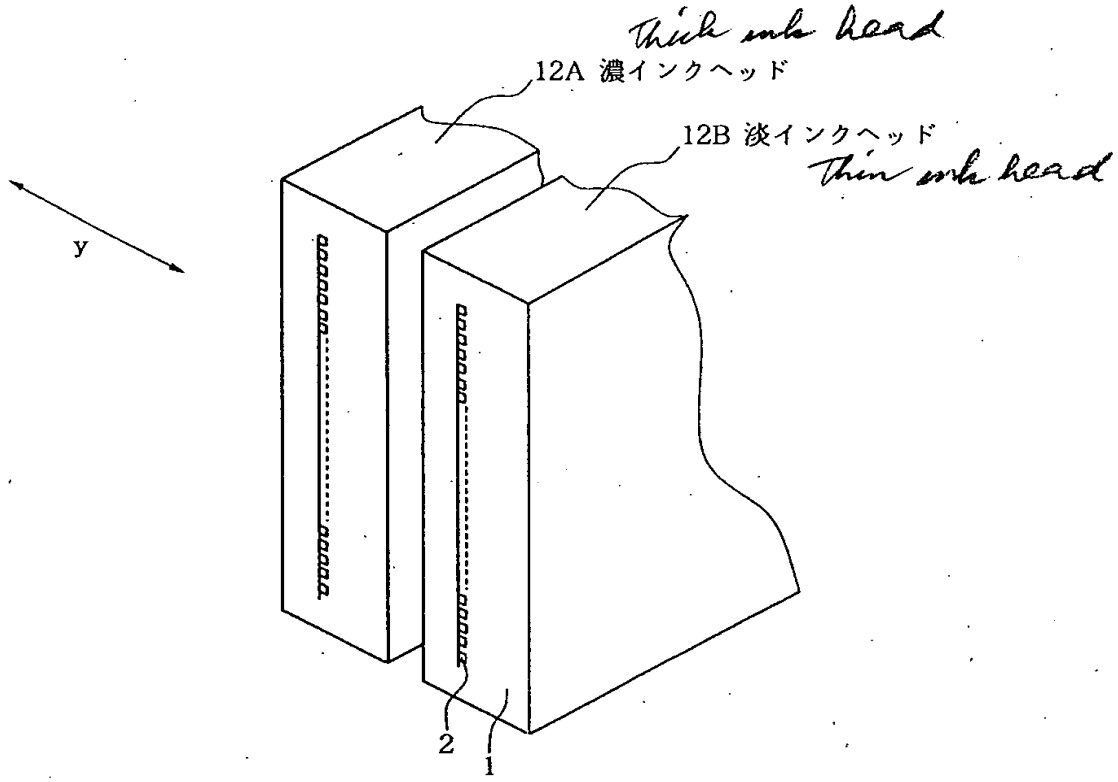
26 ... cap unit

【書類名】　図面　[Name of the Document] Drawings

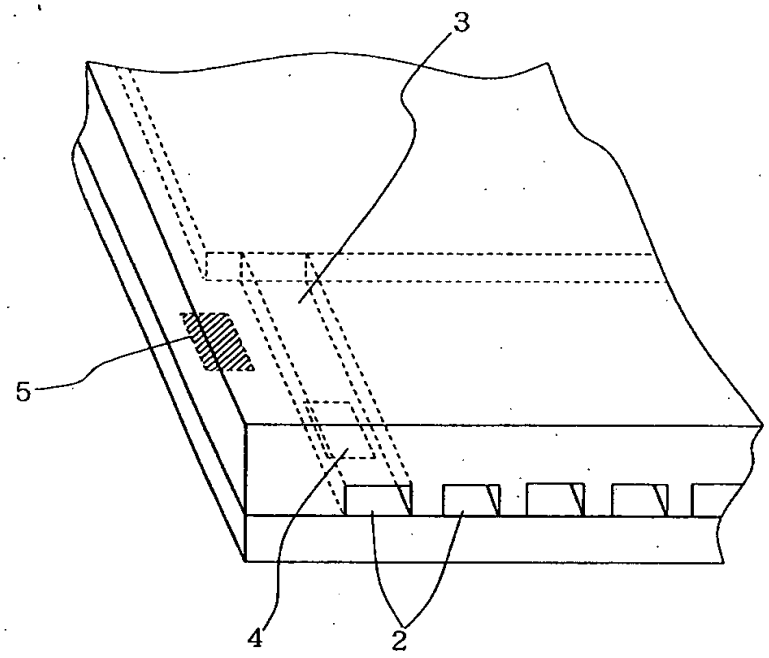
【図１】　Fig. 1



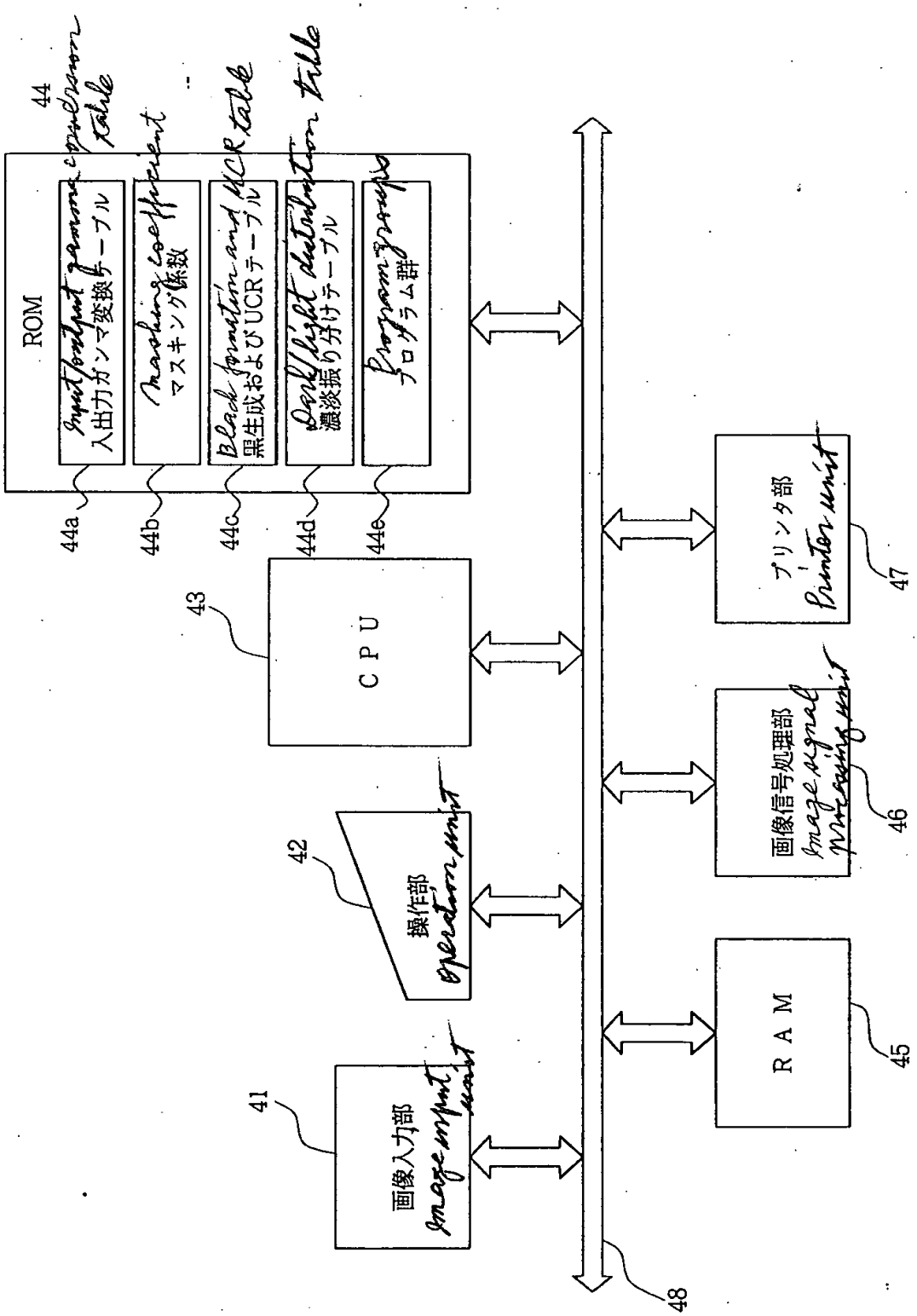
【図２】 Fig. 2



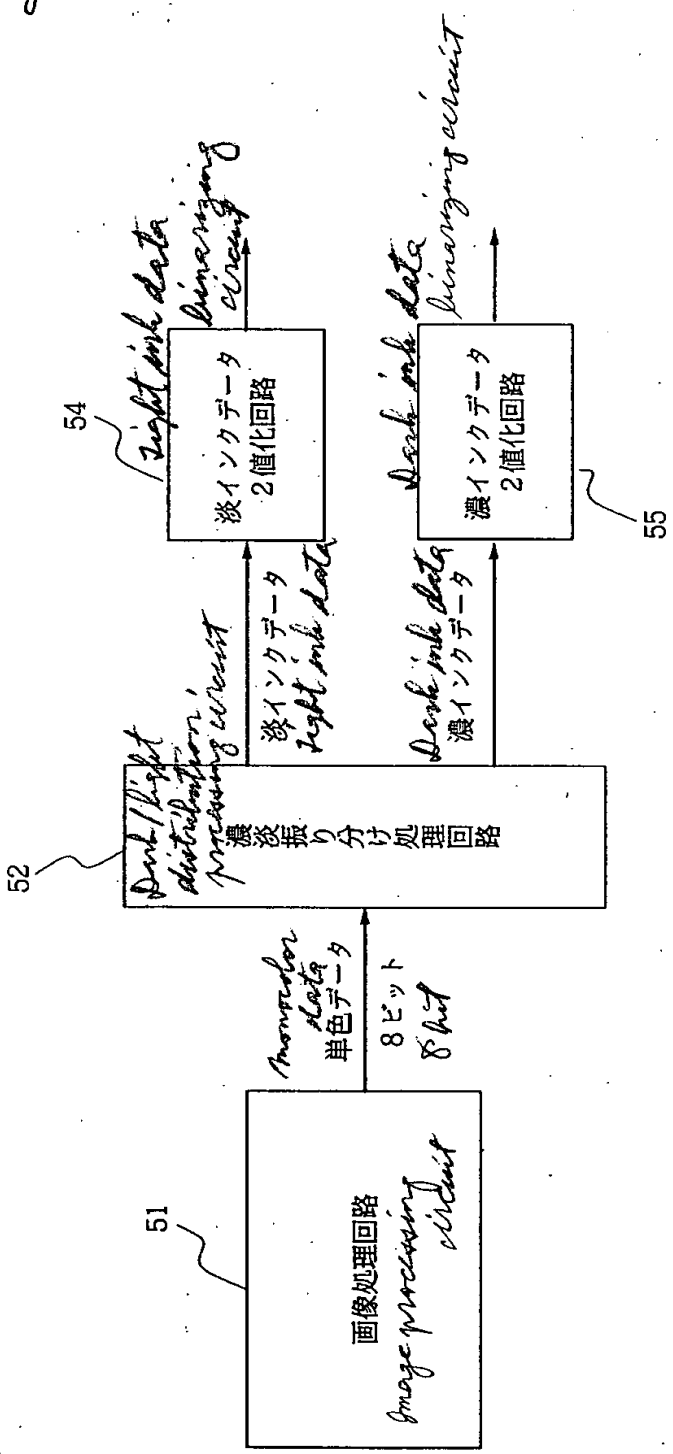
【図３】 Fig. 3



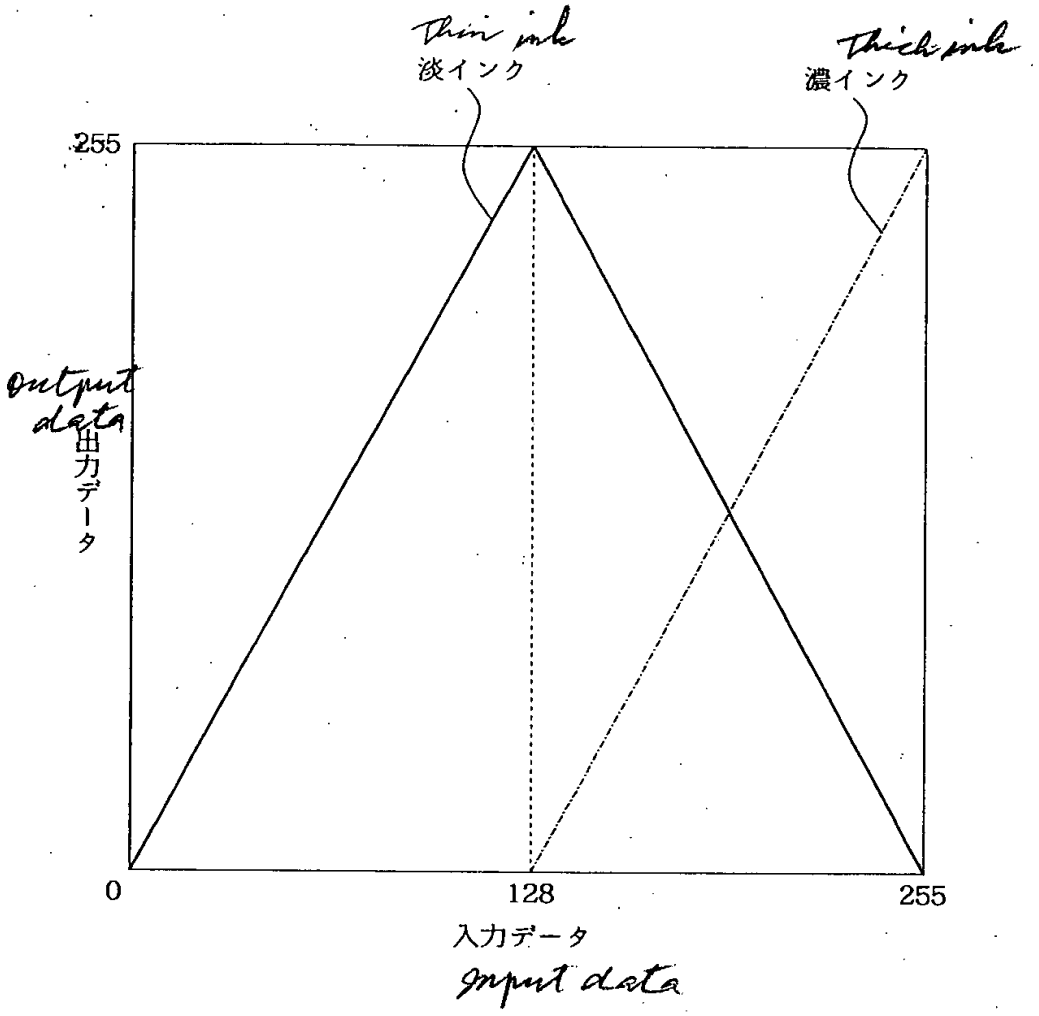
【図４】 Fig. 4


ROM
入出力ガンマ変換テーブル
マスキング係数
黒生成およびUCRテーブル
濃淡振り分けテーブル
プログラム群
44
44a
44b
44c
44d
44e
CPU
43
画像入力部
41
操作部
42
R A M
45
画像信号処理部
46
プリンタ部
47
48

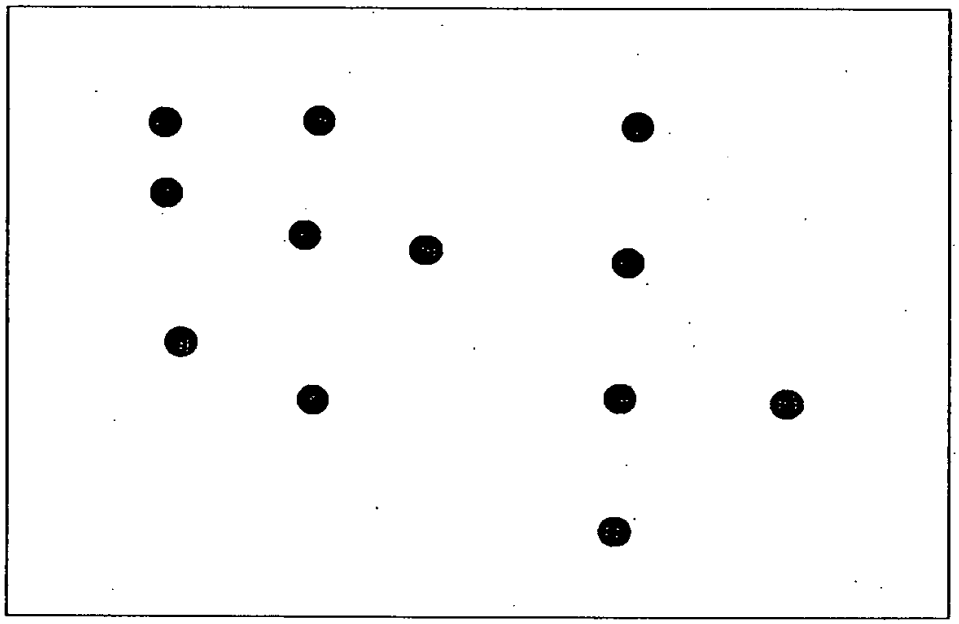
【図５】 Fig. 5


51
画像処理回路
8ビット
単色データ
52
濃淡振り分け処理回路
淡インクデータ
濃インクデータ
54
淡インクデータ
2値化回路
55
濃インクデータ
2値化回路

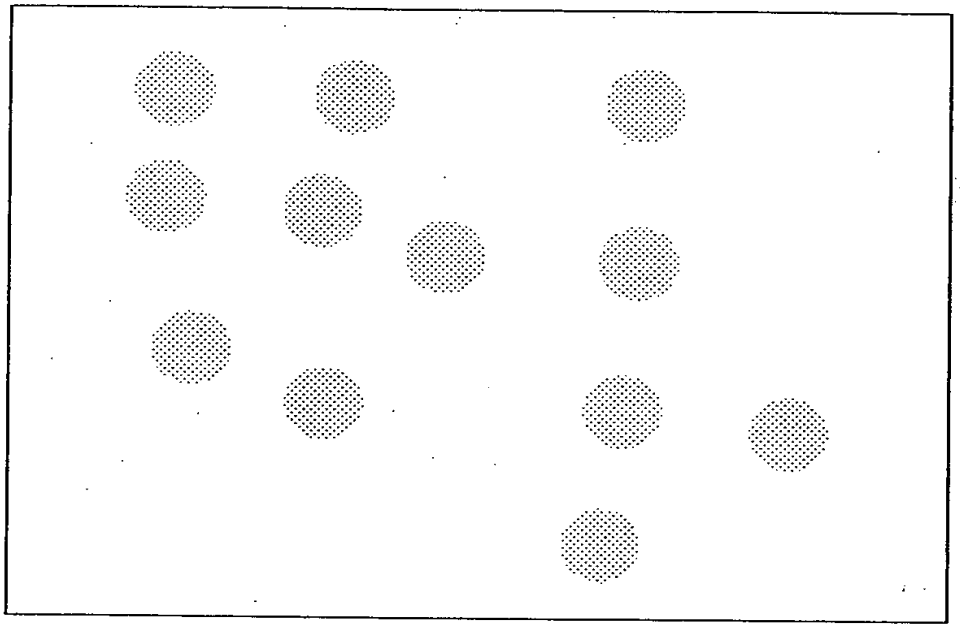
【図６】 Fig.6


Thin ink
淡インク
Thick ink
濃インク
255
output data
出力データ
0
128
255
入力データ
input data

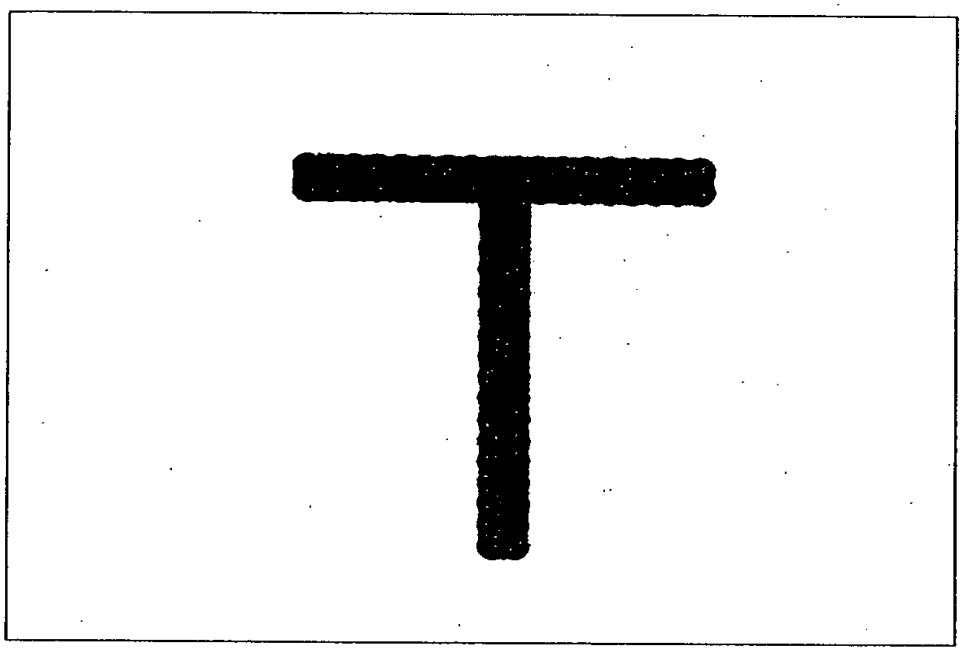
【図７】 Fig 7



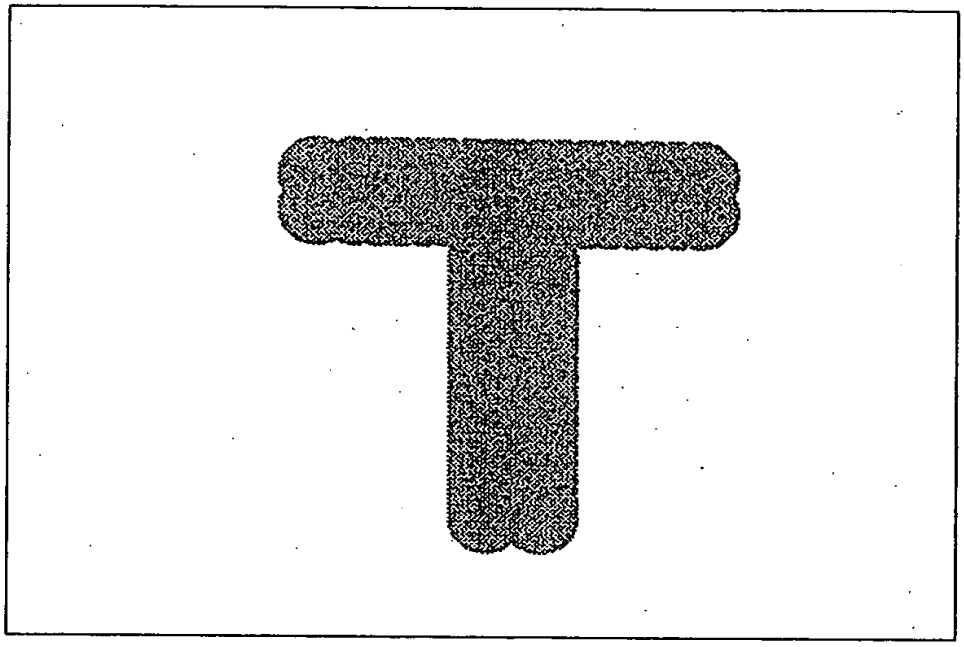
【図８】　Fig.8



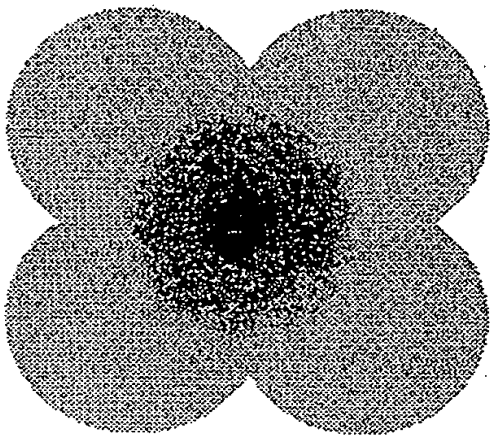
【図９】 Fig. 9



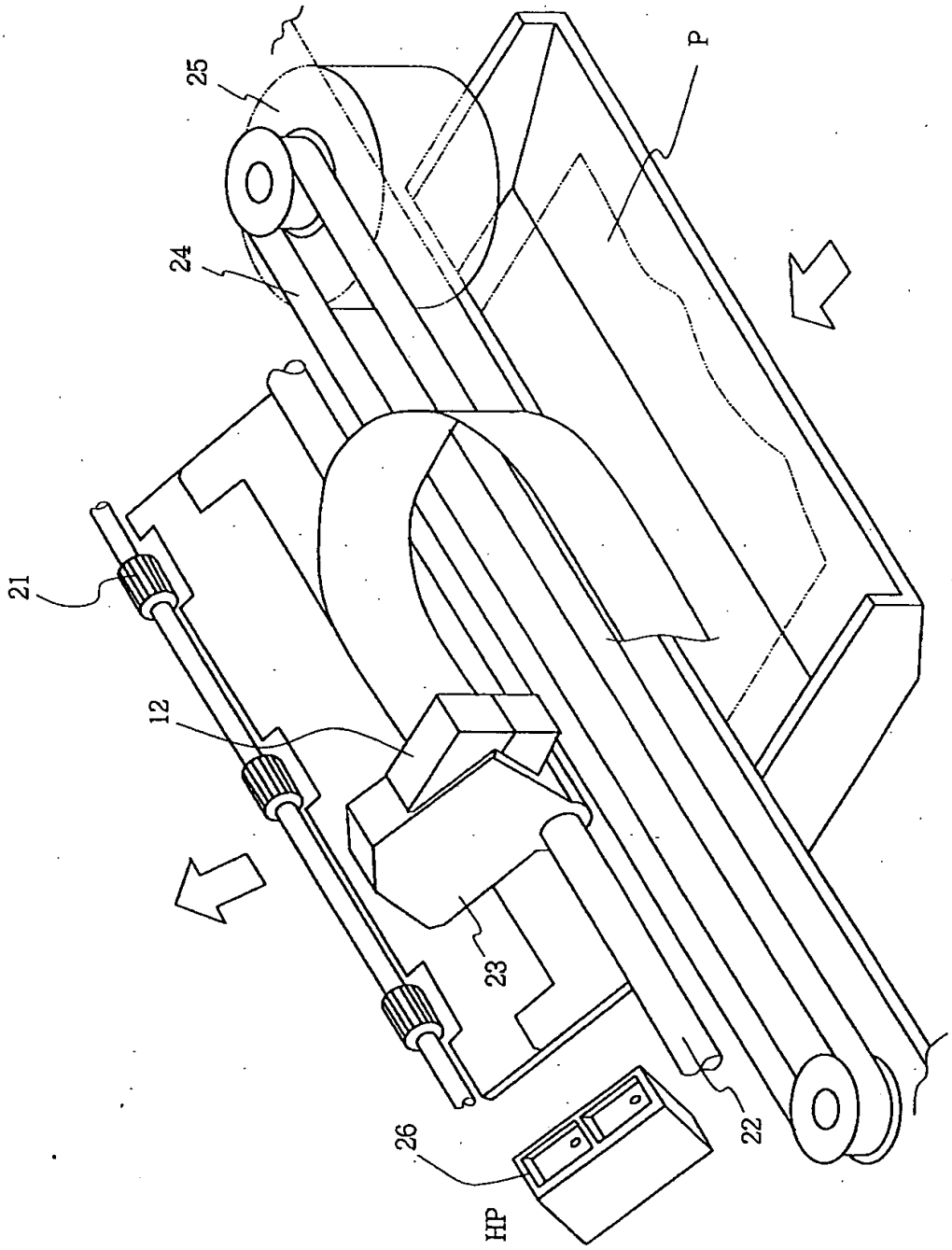
【図１０】 Fig. 10



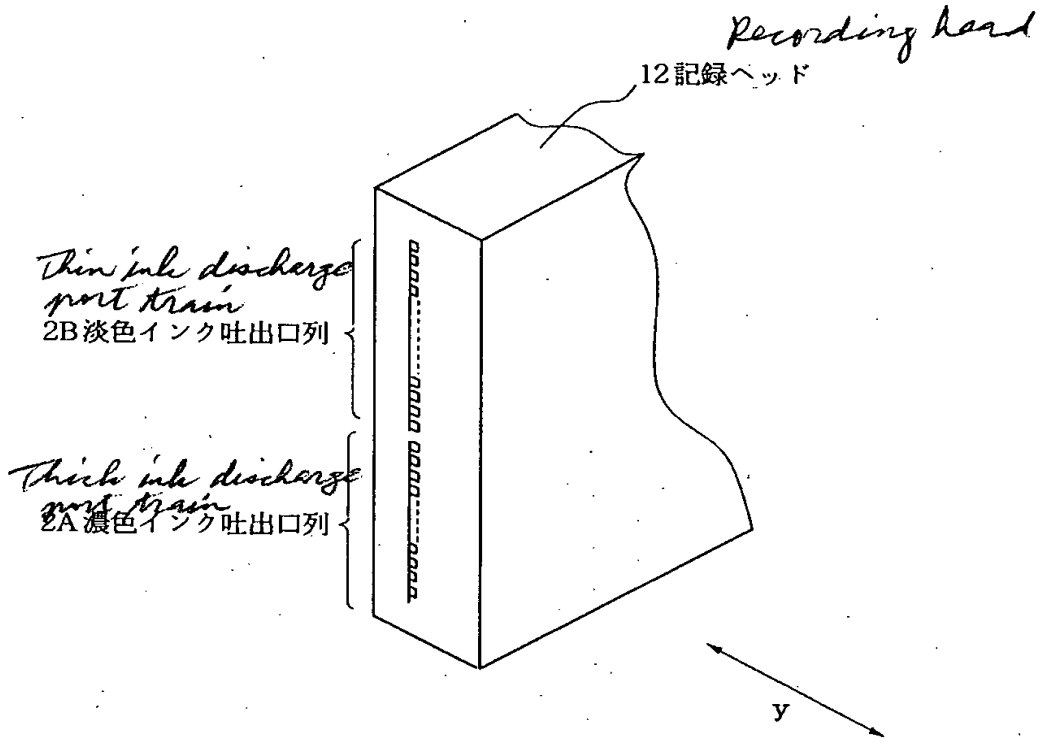
【図１１】 Fig. 11



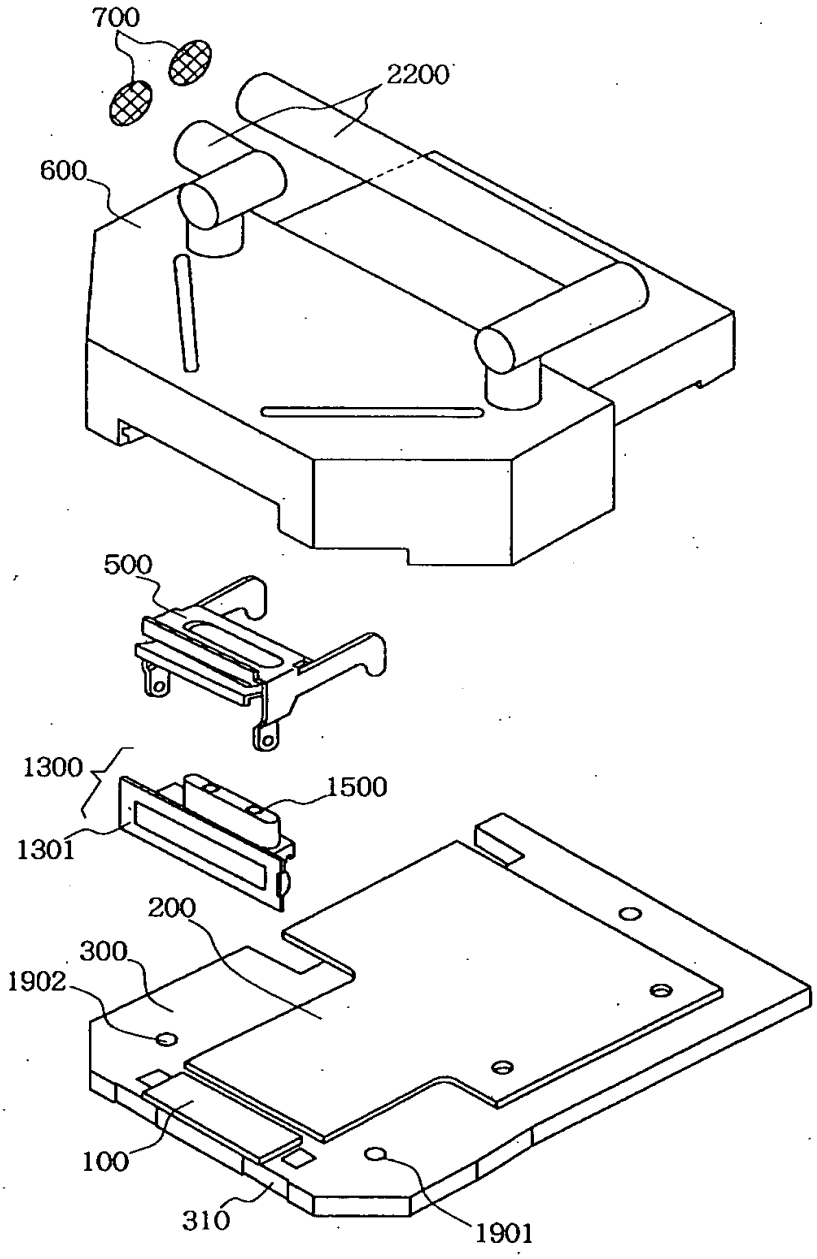
【図１２】 Fig. 12



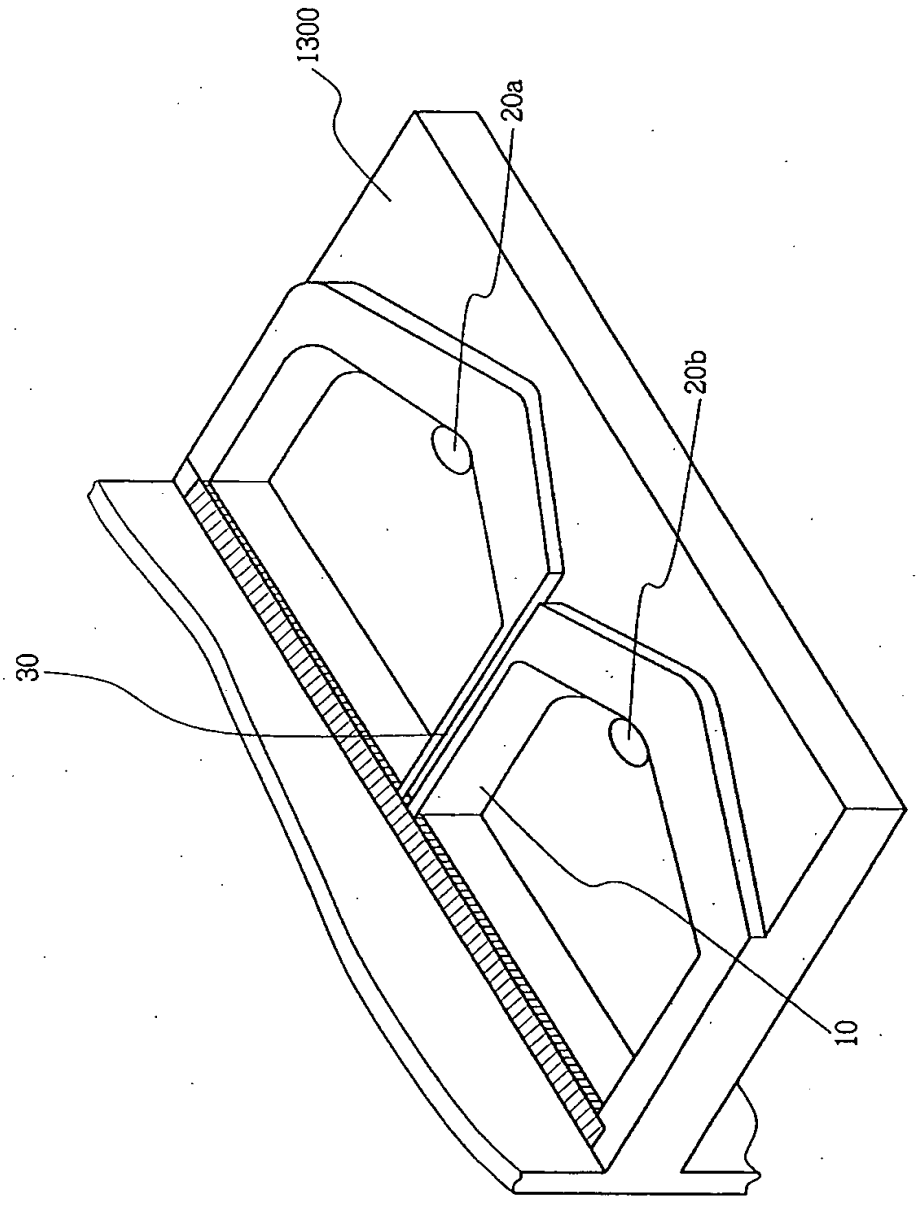
【図１３】 Fig. 13


Recording head
12記録ヘッド
Thin ink discharge port train
2B淡色インク吐出口列
Thick ink discharge port train
2A濃色インク吐出口列
y

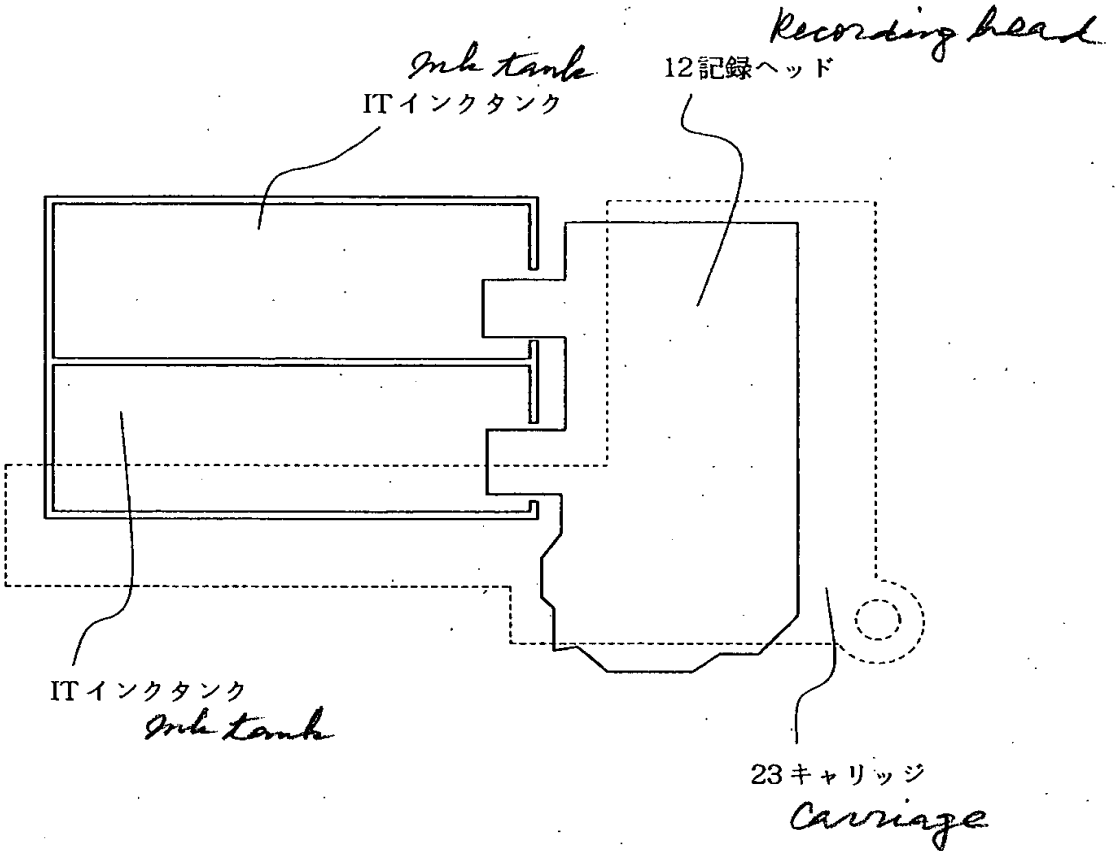
【図１４】 Fig. 14



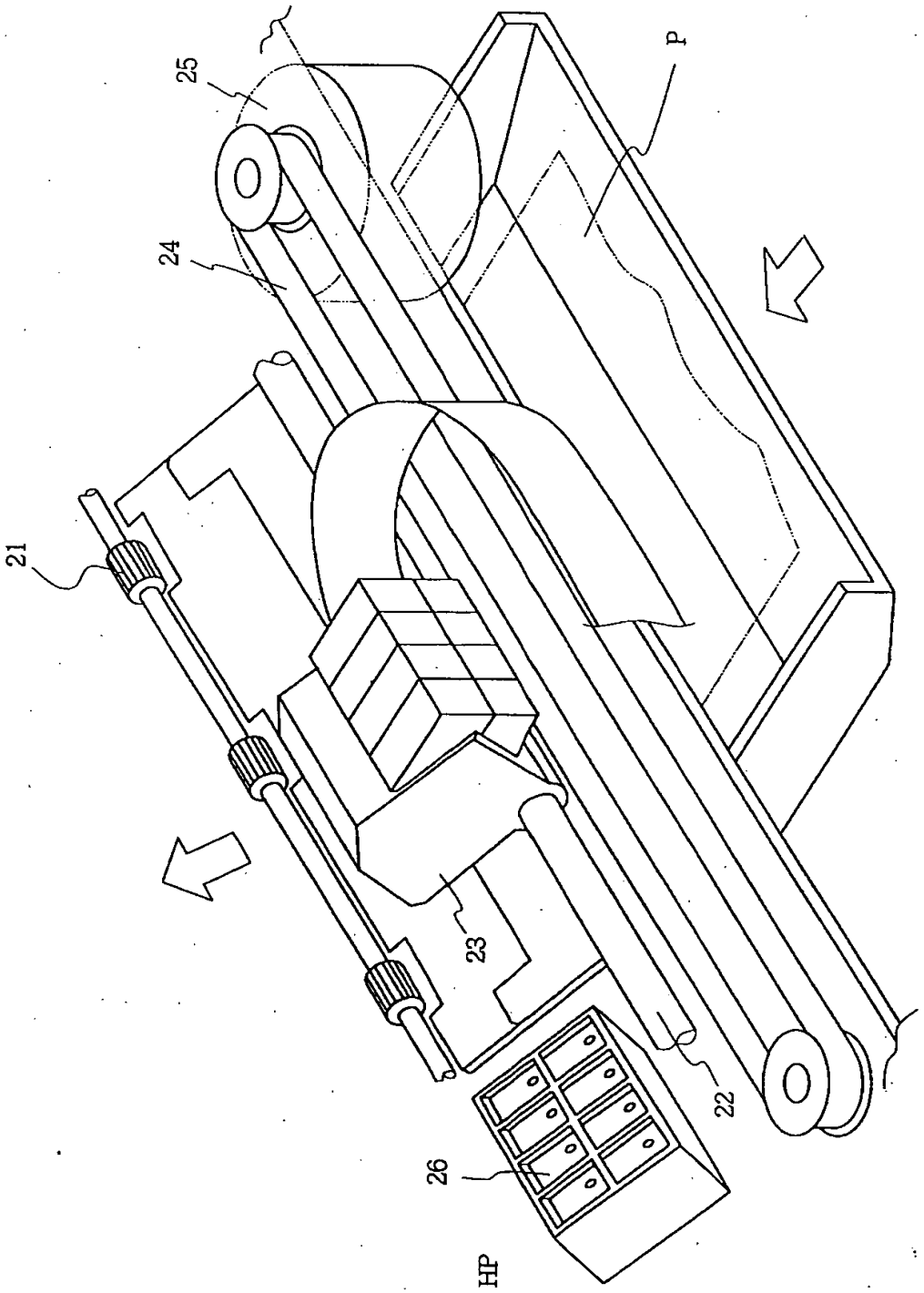
【図１５】 Fig. 15



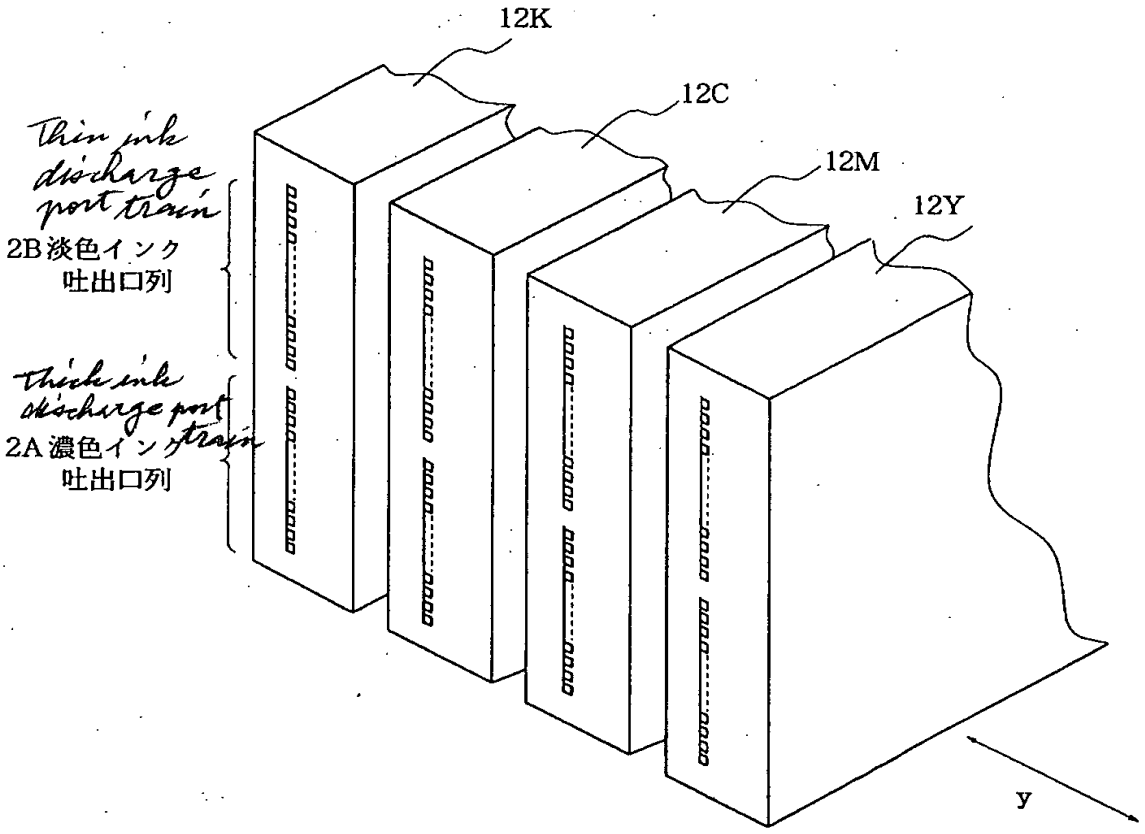
【図１６】 Fig. 16


Recording head
Ink tank
12記録ヘッド
ITインクタンク
ITインクタンク
Ink tank
23キャリッジ
Carriage

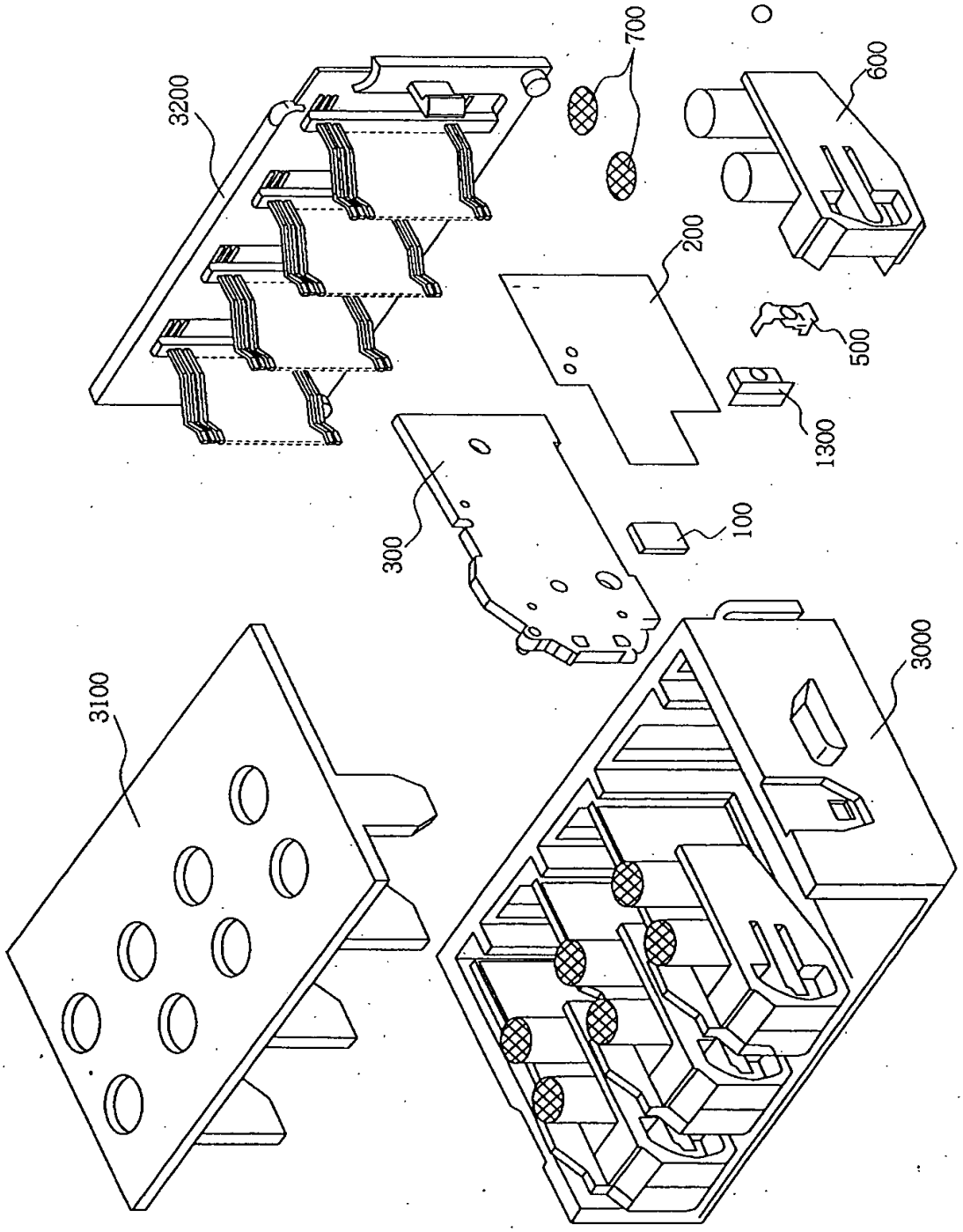
【図１７】 Fig. 17



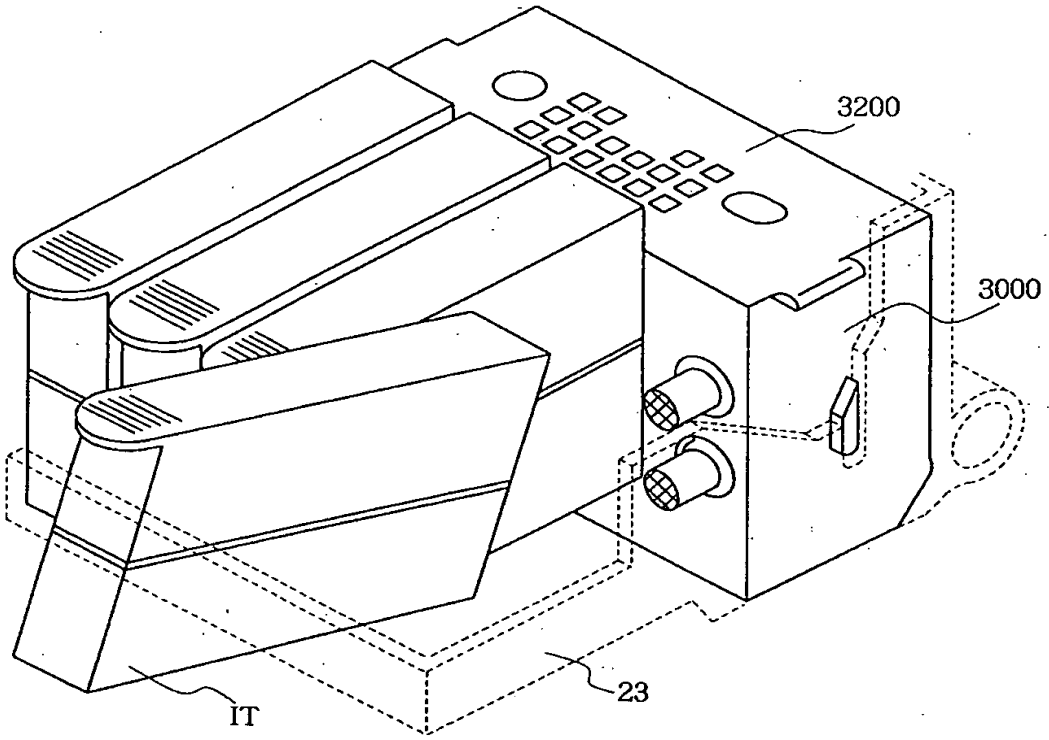
【図１８】 Fig. 18


12K
12C
12M
12Y
Thin ink discharge port train
2B淡色インク吐出口列
Thick ink discharge port train
2A濃色インク吐出口列
y

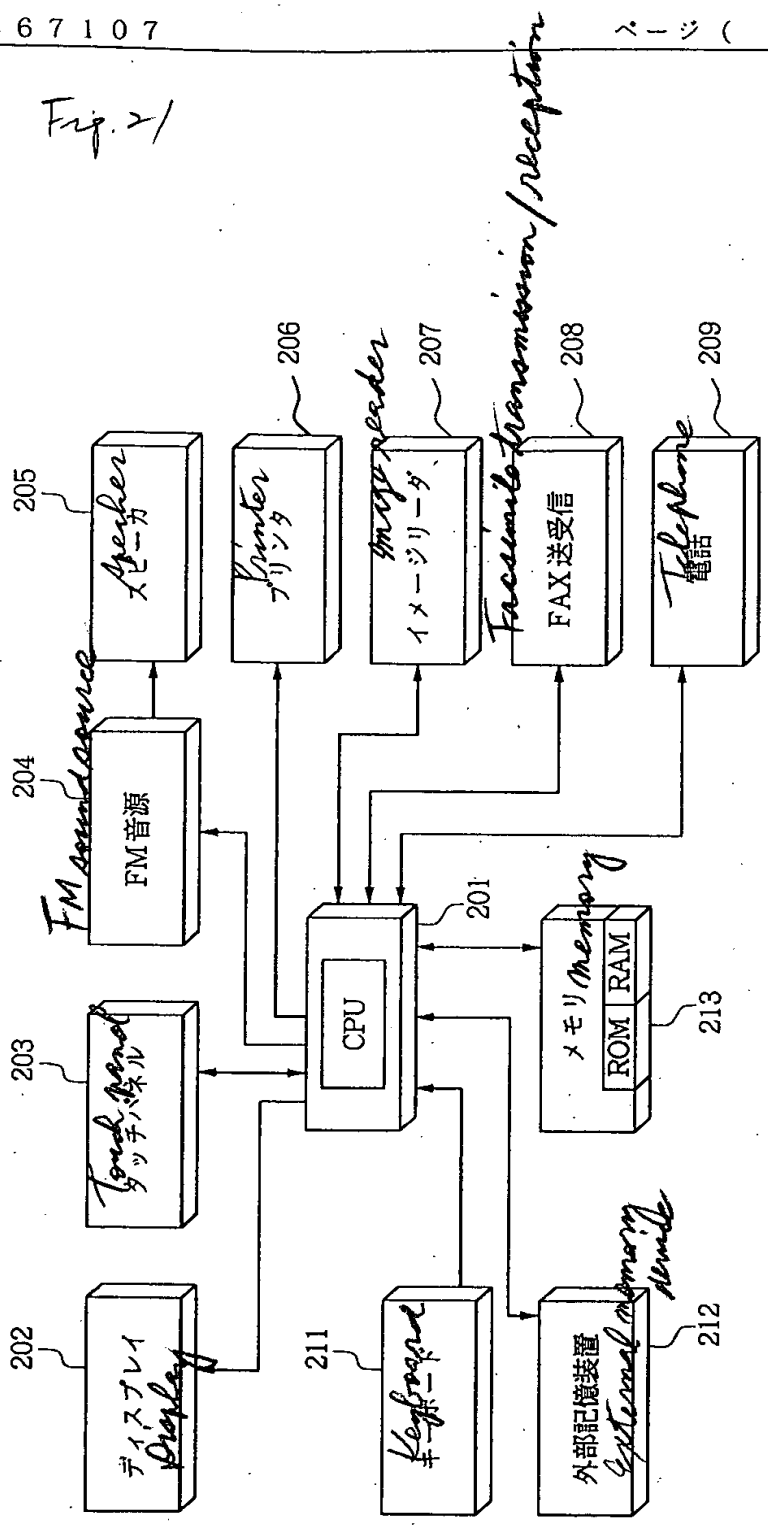
【図１９】 Fig 19



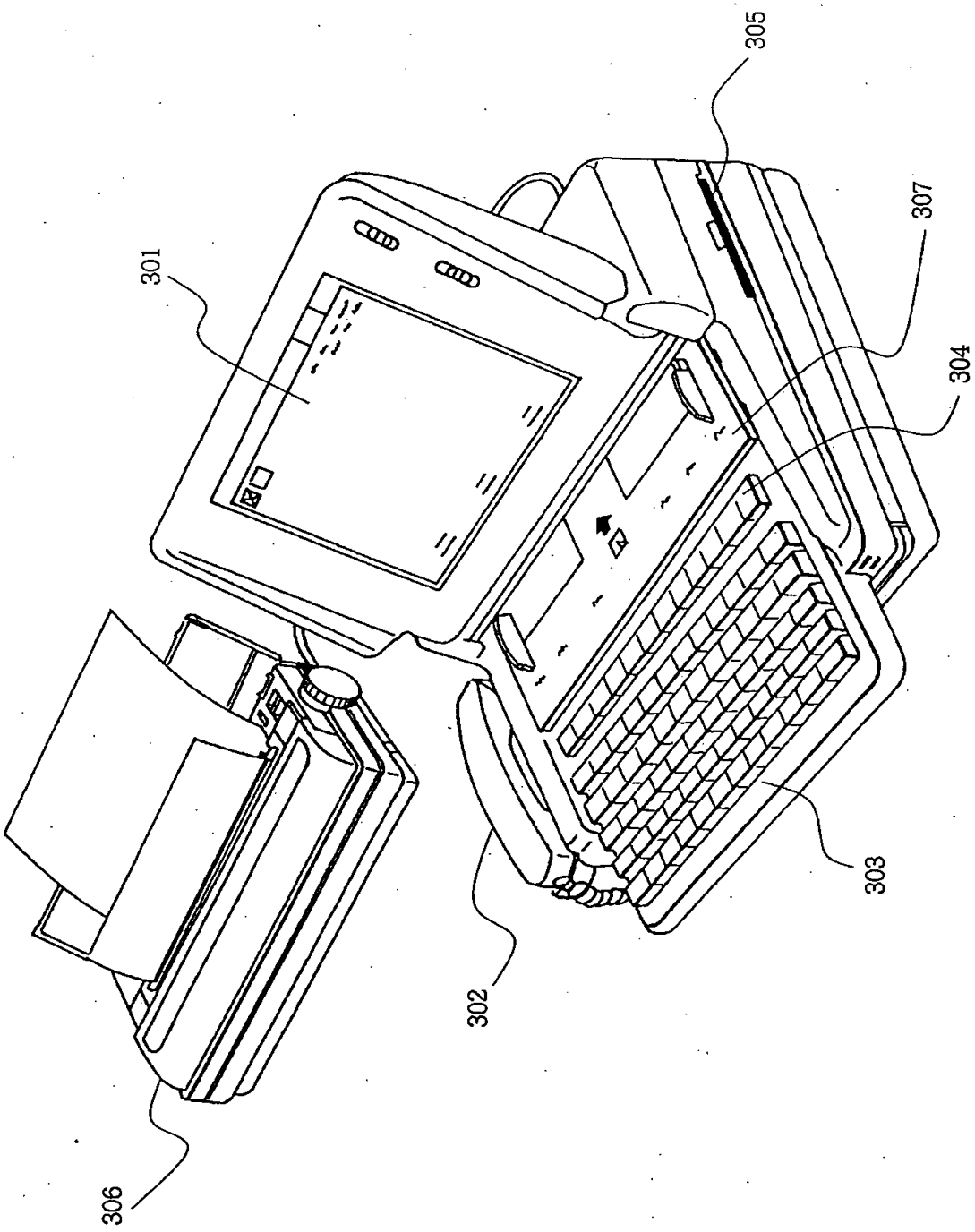
【図２０】 Fig.20



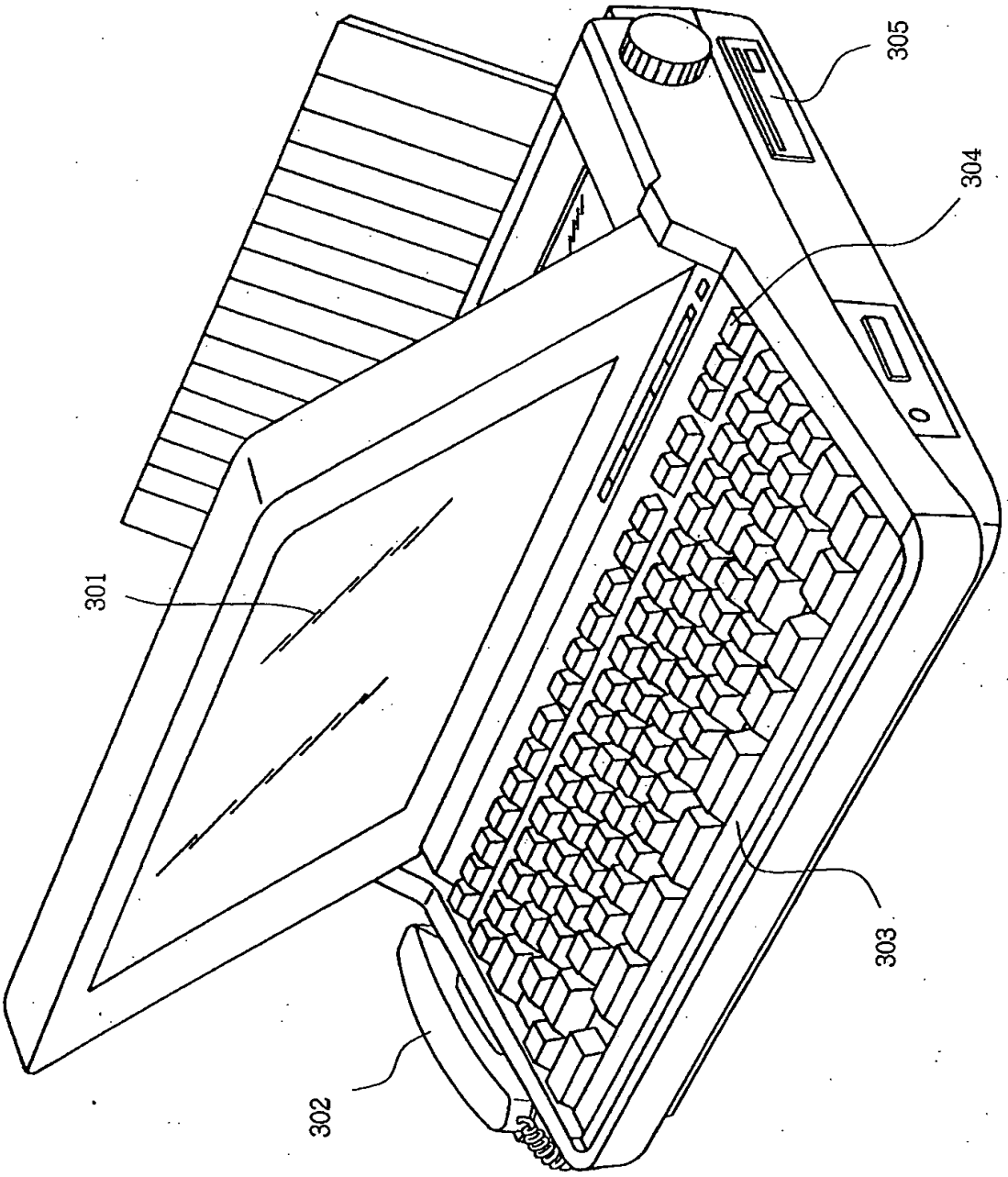
【図２１】 Fig. 21


205
スピーカ
Speaker
206
プリンタ
Printer
207
イメージリーダ
Image reader
208
FAX送受信
Facsimile transmission/reception
209
電話
Telephone
204
FM音源
FM sound source
203
タッチパネル
Touch Panel
202
ディスプレイ
Display
CPU
201
メモリ
Memory
ROM
RAM
213
211
キーボード
Keyboard
212
外部記憶装置
External memory device

【図２２】 Fig. 22



【図２３】 Fig. 23



[Name of the Document] Abstract

[Abstract]

[Object]

An object of the present invention is to obtain an image with reduced graininess and excellent gradation.

[Constitution]

An ink with high penetrability on a recording medium and high dot diffusion is discharged from a recording head 12B for thin ink, while an ink with low penetrability on the recording medium and low dot diffusion is discharged from a recording head 12A for thick ink, thereby forming an image on the recording medium. Thus, there is formed the image with reduced graininess and excellent gradation.

[Elected Drawing]

Figure 2